AGRICULTURAL ENGINEERING

SEPTEMBER • 1952

The Challenge for Engineers in Farm Machinery Design *Charles J. Scranton*

Factors Affecting the Wind Resistance of Asphalt Shingles *M. L. Esmay and Henry Giese*

Engineering Appraisal of Soil and Water Conservation Practices *Dwight D. Smith*

A Comparison of Various Methods of Brooding Poultry *J. Roberts, J. E. Matson, et al*

Technique of Measuring Water Drops from Irrigation Sprinklers *Robert L. Green*

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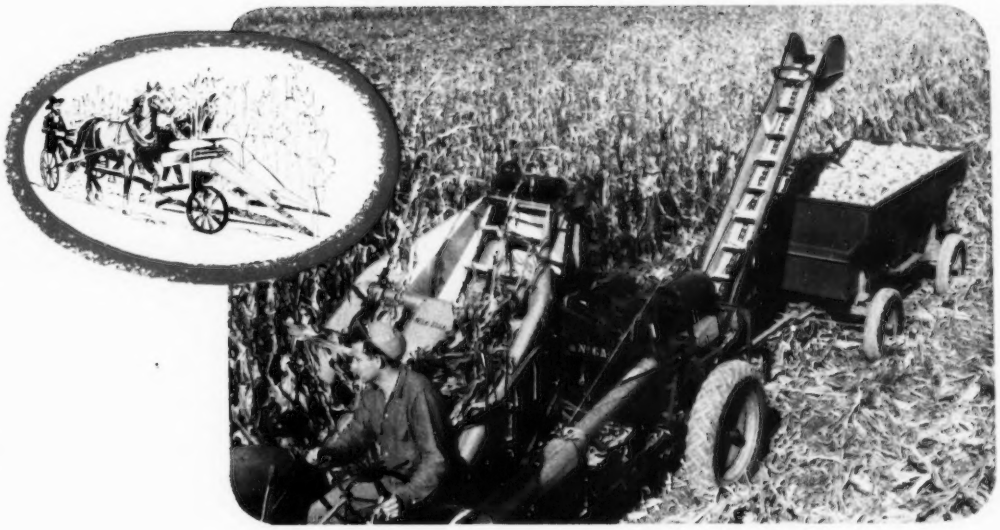

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CONTENTS FOR SEPTEMBER, 1952

Vol. 33, No. 9

EDITORIALS ... 543

THE GRADUATE ENGINEER IN FARM EQUIPMENT DESIGN ... 545
By Charles J. Scranton

FERTILIZER PLACEMENT AFFECTS SUGAR-CANE YIELDS ... 548
By M. A. Lugo-Lopez and M. B. Martinez

FACTORS AFFECTING THE WIND RESISTANCE OF ASPHALT SHINGLES ... 549
By Merle L. Esmay and Henry Giese

A 20-YEAR APPRAISAL OF ENGINEERING PRACTICES IN SOIL AND WATER CONSERVATION ... 553
By Dwight D. Smith

COMPARISON OF VARIOUS METHODS OF BROODING ... 557
By J. Roberts, J. S. Carter, and W. E. Matson

EFFECTS OF IRRIGATION DROPLET SIZE ON INFILTRATION AND AGGREGATE BREAKDOWN ... 559
By Gilbert Levine

MECHANIZATION OF PEANUT PRODUCTION IN TEXAS ... 561
By J. W. Sorenson

A PHOTOGRAPHIC TECHNIQUE FOR MEASURING THE SIZES AND VELOCITIES OF WATER DROPS FROM IRRIGATION SPRINKLERS ... 563
By Robert L. Green

PROPOSED ASAE STANDARD: HEADED DRILLED PINS ... 570

PROPOSED ASAE RECOMMENDATION: DAIRY HOUSING TERMINOLOGY ... 572

NEWS SECTION ... 576

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Austin-Western Co.	585	Milsco Mfg. Co.	576
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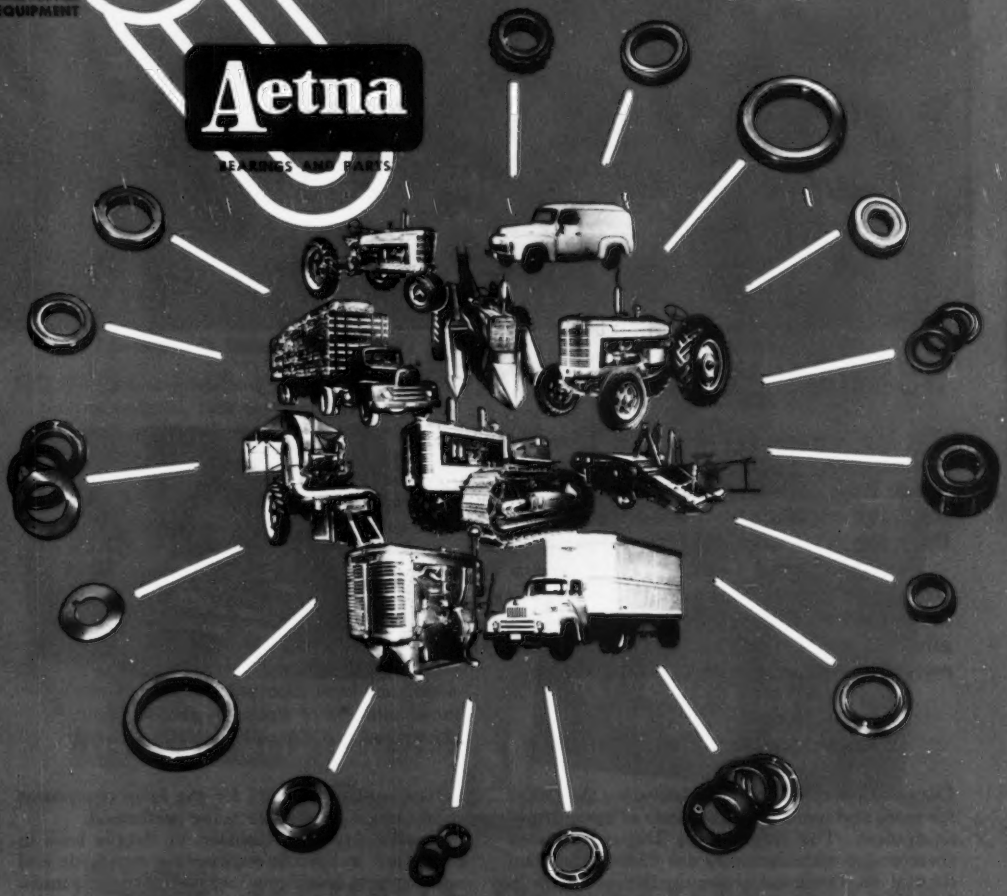

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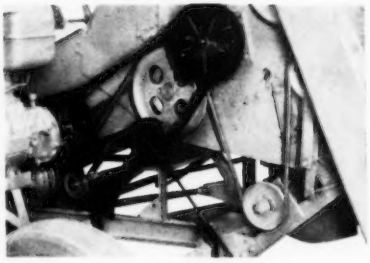

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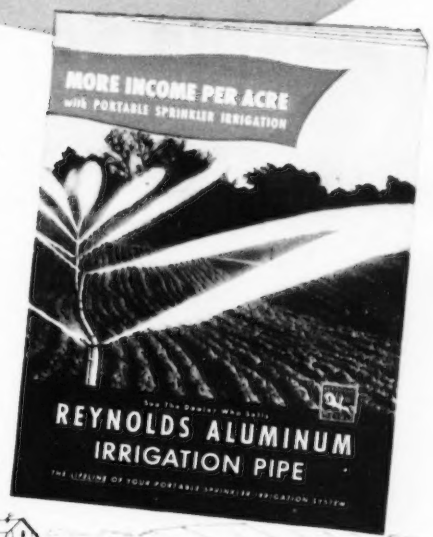

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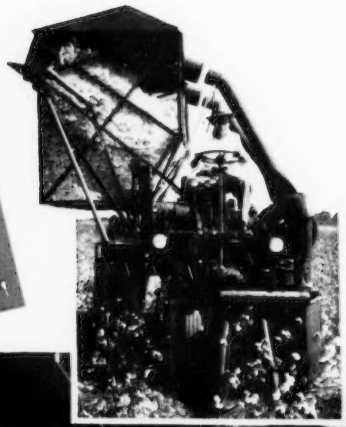

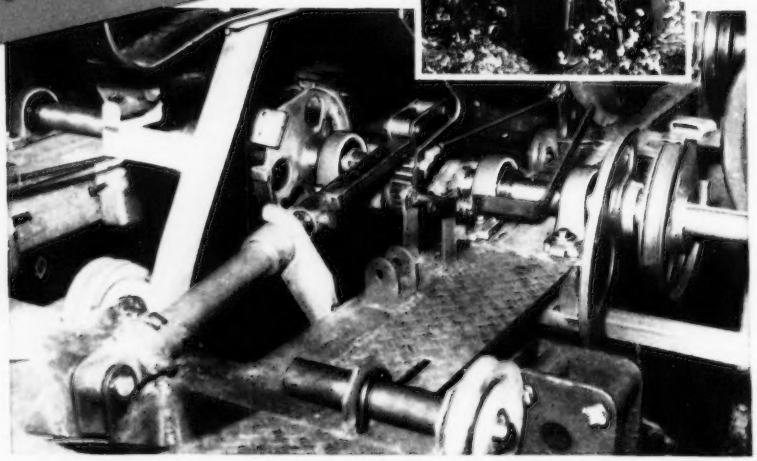

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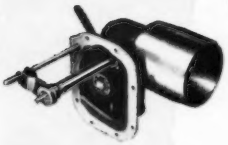

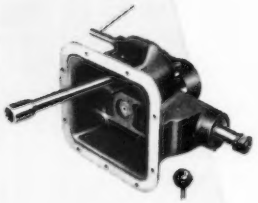

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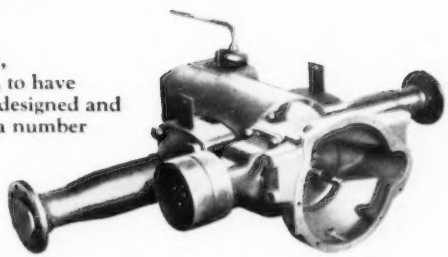

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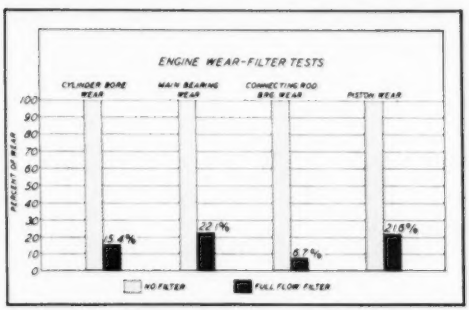

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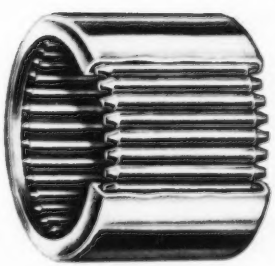

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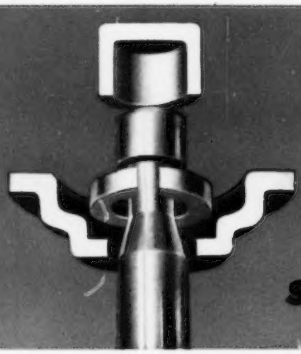

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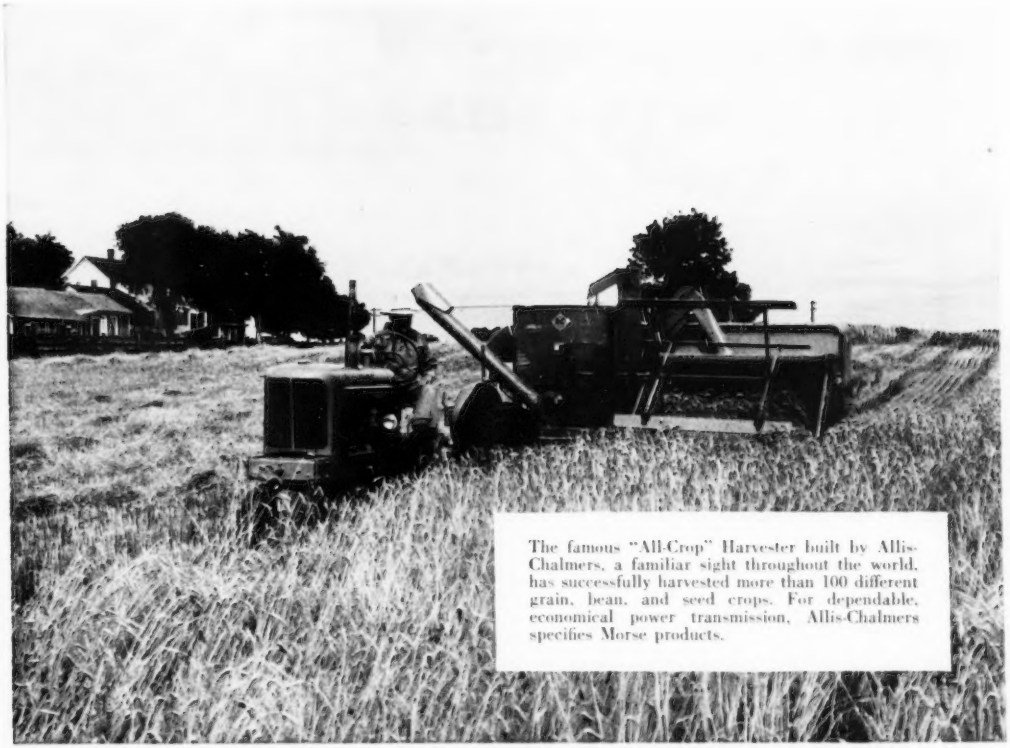

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Let us give you full details on Morse Roller Chains and Sprockets, Double-Pitch Roller Chains, Roller Chain Couplings, Flexible Couplings, Clutches or other products in the complete Morse line. Write us about any application you have in mind.

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FOR DEPENDABILITY IN THE FIELD Engineer

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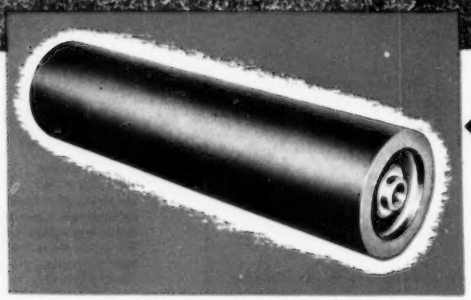

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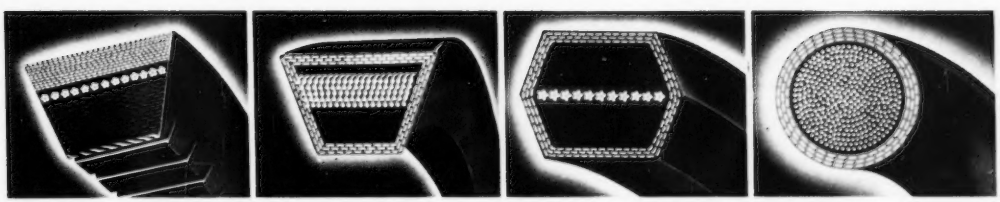

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*T.M.

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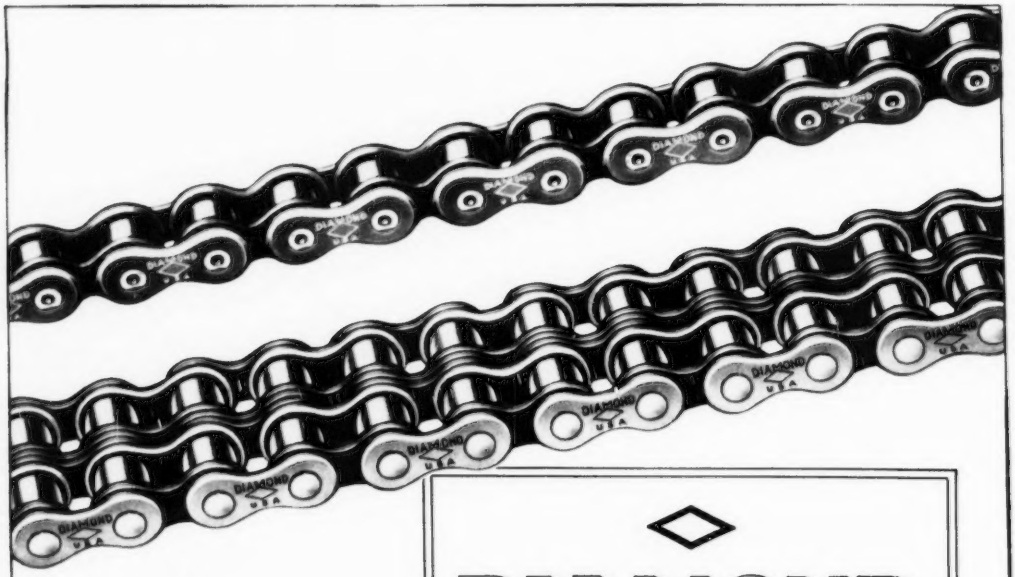

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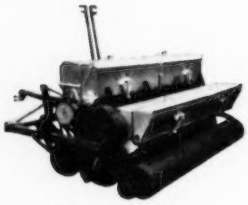
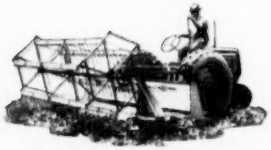


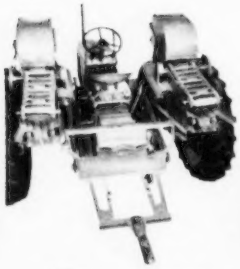
Brillion Grain Drill and Grass Seeder Combination

Gleaner 12 foot combine



Hume Tractor-Rower Harvester

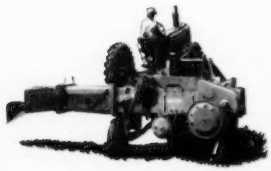
Minneapolis-Moline 2-Row Huskor



Oliver Tractor Mounted Corn Picker

Gehl Forage Harvester

Innes Bean Windrower



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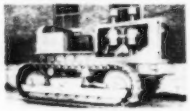

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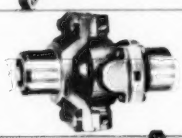
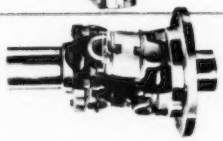


for Mining Machinery



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LINK-BELT integrates all components to give you the right screw conveyor for your machines

Here's how "total engineering" works for you when you buy Link-Belt Screw Conveyors. First, Link-Belt conveyor specialists analyze your needs—then recommend the right components. That means you get the exact type and size for your particular requirements . . . engineered to suit *your* needs.

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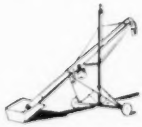

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EDITORIAL

A Factor in Publication Values

IT HAS been brought to our attention that we might well comment editorially on the fact that AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.

This ABC, as it is abbreviated in the periodical trade, is "a cooperative association of advertisers, advertising agencies, and publishers, for the verification of circulation of newspaper and periodical members in the United States and Canada."

In brief, this organization helps its member publishers do a good job for their readers. Most directly it relates to advertising, and that, in addition to being of important informational value to readers, supports the publication of editorial material.

Based on its semi-annual audits, ABC issues copies of our publisher's statement covering the character, distribution, and total amount of our circulation, as well as general information on AGRICULTURAL ENGINEERING and other factors influencing its value as an advertising medium.

This places our journal on a competitive level above that of publications which fail to provide the same or similar verification of circulation claims. It places our advertising promotion on a sound business basis consistent with the ethics, objectivity and quantitative evaluation of engineering.

A related further result is a selective influence on the character of advertising carried. The ABC statements show that our circulation is concentrated among a special group of technically and professionally qualified men. They are men whose recommendations strongly influence the selection and purchase of products with engineering merit as materials, components, or complete-unit products for farm use under specified conditions. AGRICULTURAL ENGINEERING shows up as an appropriate medium for advertising in line with the technical and professional interests of this group. It clearly is not a mass medium appropriate to the advertising of consumer goods. Neither does it appear as a promising medium for advertising products which lack the merit to stand up under critical analysis by engineers. Hence, practically one hundred per cent of the advertising in AGRICULTURAL ENGINEERING has a positive informational value to its readers, concerning products and services meriting consideration in this field.

It must be remembered, further, that advertising does not detract from the space available for editorial matter. Rather, it finances the publication of additional meeting papers and contributed articles. This is particularly important in the current period of active demand for publication to keep pace with research, development and application trends in agricultural engineering progress.

Membership in ABC is thus a sound business measure contributing to a volume and quality of publication serving the mutual interests of agriculture, agricultural engineers and the manufacturers of engineered products useful in agriculture.

Economics of Farm Processing

OUR attention has been called to a phase of farm processing not covered in the editorial entitled, "Sound Promotion of Farm Processing," which appeared in AGRICULTURAL ENGINEERING for August, 1952. Our correspondent stresses the relative rigidity of processing and marketing costs in contrast to the more widely fluctuating prices paid to the farmer for raw materials.

In the marketing of Georgia pimientos, for example, the U.S. Bureau of Agricultural Economics reports that during the five-year period 1947-51, prices paid to farmers varied plus or minus 28.2 per cent from the 1946 at-the-plant price taken as a base. In the same period, production and marketing costs varied less than plus or minus 2 per cent from the 1946 cost again taken as a base. On the average over the period, of the total retail price of a can of pimientos, 78 per cent went to the processing and marketing interests leaving for the farmer the remaining 22 per cent.

In many instances the proportion of the total retail price going to the farmer in payment for raw materials is small, and furthermore this small fraction is subject to greater fluctuation than are processing and marketing changes. It has been on this basis that agricultural economists have pointed to the seriousness of fluctuating price levels in relation to the economic welfare of farmers.

In the sound promotion of farm processing, economic consideration cannot be omitted. It might well be that conducting more of the processing and marketing functions on the farm where this is possible, would have a tendency toward stabilizing prices of certain farm products and hence the incomes of the farmers concerned.

Utilization Engineering

A PIONEER in the development of power supply and transmission for rural-electric service recently received the Lamme Medal, one of the highest awards of the American Institute of Electrical Engineers, for his contributions to that field. In closing his acceptance address that engineer, A. E. Silver, now retired, took a forward look at rural electrification of special interest to agricultural engineers:

"The engineering art is not static, neither is the growth of America, and particularly rural America. I believe the basic engineering principles for farm service have been well established. The big job which now remains is to continue expanding the profitable utilization of electricity to attain maximum benefits from electrification for all. This sector of farm electrification, I am confident, still holds large potentialities for engineering endeavor. It is gratifying to note at the present time throughout the nation the effort concentrated on this phase of the work."

This utilization engineering means relating electric-power potentialities to distinctively agricultural considerations. It calls for the development, adaptation, and application of electrical and engineering principles, methods, and devices to serve the requirements of agriculture not only as it is but as it can be expected to develop. While meeting active farm demand for electrical means to help handle today's farm jobs, the larger engineering opportunity in rural electrification may be to analyze and serve the trend of progress in agriculture.

New Uses for Farm Equipment

A RECENT news release indicates that a side-delivery rake has been successfully used as a special-purpose weeder and cultivator.

This emphasizes the point that progress in farm mechanization is the summation of contributions from a wide variety of sources. In this particular case many agricultural engineers had known about the rake and its characteristics for a year or more. They knew about its use for the primary purpose of hay raking for which it was designed and built. How much or little thought they may have given to its possible use for other purposes is uncertain. It was a specialized farmer, a nurseryman with a specific cost-cutting problem, who saw in this particular rake a solution to his problem.

How many other pieces of farm equipment, or components thereof, involve construction, motions, controls, or other features which might similarly prove useful in other unrelated applications? The current example adds point to the question.

The economics of manufacturing, distribution, and use of production goods favor the widest practicable use of standard items. Farm users will benefit in reduced costs and increased availability of service, wherever added effective uses can be found or developed for standard items or components of existing farm equipment.

Various types of specialty farming have particularly difficult mechanization problems, in that they offer only a limited market for specialized equipment. They represent a promising field for surprising and effective new uses for standard equipment, with or without minor modifications, as illustrated by the finding that a side-delivery rake has possibilities as a weeder.

One Extra Step

. . but it's a giant stride in farm implement performance

Oliver Row Crop "88" pulling a 144 Disc Plow equipped with Ingersoll Heat Treated Discs

What a difference just one manufacturing step makes in the field performance of tillage discs! Ingersoll *takes* that extra step in heat treating all Ingersoll discs by an exclusive, long draw process.

This long draw assures proper hardness, and greater uniformity in the steel structure of Ingersoll discs. And that eliminates warping and brittleness, adds extra toughness and resistance to abrasion.

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AGRICULTURAL ENGINEERING

VOL. 33 SEPTEMBER, 1952 NO. 9

The Graduate Engineer in Farm Equipment Design

By Charles J. Scranton

MEMBER ASAE

THIS paper is primarily concerned with the graduate engineer who expects to make a career of farm equipment design. Its object is to consider some of the factors which should influence such a decision. For this purpose the paper has been divided into four main subjects, and based on personal experiences:

1 What industry may expect from the graduate engineer

2 What the graduate engineer may expect from industry

3 The general purpose of a design organization, its make-up and personnel requirements

4 A glimpse into the past and some thoughts for the future.

What Industry May Expect. It is reasonable for industry to assume that the graduate comes to it with a trained mind, the ability to think logically and to analyze and classify information, and a young man's enthusiasm.

The graduate is expected to realize that he is not a finished engineer and that much practical experience must be added to his theoretical knowledge. Only industry can offer this opportunity.

It is expected that he will be willing to undertake any reasonable assignment to get this practical experience in manufacturing, shop practice, field operation, and the drafting room.

It is further expected that his training will enable him to express his thoughts clearly through satisfactory technical reports on any assignments within the limits of his ability.

It is assumed he will be willing to work with ideas submitted by others until he has a thorough working knowledge of the business and is in position to present matured ideas of his own.

He should understand that an engineer must continue to study following his college education, in order to keep up with changing methods, new processes, and advancements in the branch of design in which he is working. Also, since he wishes to become allied with design, he must understand that the logical thing is to develop the design first on the drawing board. He must be willing to spend a considerable period of time on this work. Entirely too many engineers feel that the drawing board is to be avoided or endured, while actually it is the most satisfactory means of translating rough ideas into a coordinated mechanism.

What the Graduate Engineer May Expect from Industry. The graduate has a right to expect a number of things when he becomes allied with industry, and I venture to suggest a few of them.

He is entitled to the opportunity of self-expression within the limits of his training. This is, of course, a progressive process.

He is entitled to an opportunity to learn manufacturing methods, cost analysis, processing methods, and other factors which affect original design.

It is my belief that every engineer should work in the field with the products with which he becomes allied, because it is in actual operation that the shortcomings of the products are observed.

After a reasonable period of training, he should be assigned to a project which permits the development of his own ideas, which are limited, of course, by the nature of the company's products and its policies. It is understood by industry that every designer should have an opportunity to be allied with a worth-while cause.

Finally, he should have an opportunity for growth, limited strictly by his ability, and his compensation should be commensurate with what he can produce.

During the past fifteen years in my present association, it has been my privilege to work with more than one hundred graduate engineers, both mechanical and agricultural. These engineers have come to us from all parts of the United States and have passed through our company program. All of the key engineers in the La Porte organization are graduates of this type; others are working in other plants of our company, and some have moved into other work.

My experience has been that it takes about ten years after graduation for the young engineer to get enough experience with the various parts of our industry to qualify him as a high-grade designer, and then only if he has imagination and initiative. I know of no short cuts to this development.

It is a pleasure to state that almost without exception the graduates that have come to us have been sound morally, alert mentally, and those who have chosen to follow design work have done very well indeed.

Today's standards of farm equipment design are being raised rapidly, and there is a definite need for engineers who are willing to pay the price to carry this work forward.

The Purpose of the Design Organization. What is the purpose of the design organization and its make-up?

Its major responsibility is to supply the company with readily saleable and manufacturable products. There is, of course, no purpose in a manufacturing plant un-

The author has seen the steam traction engine and exposed-gear tractor almost completely replaced by the modern and efficient all-purpose gas tractor. The self-binder also is almost extinct, and the stationary grain thresher with its complement of at least eight bundle teams, two extra pitchers, and two additional operators have been replaced by the combine harvester. There is room for extensive further developments; indeed the design and development of better farm equipment offers a distinct challenge for the engineer of the future.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June 1952, as a contribution of the College Division.

The author: CHARLES J. SCRANTON, chief engineer, harvester division, Allis-Chalmers Manufacturing Company. Mr. Scranton was awarded the Cyrus Hall McCormick Gold Medal by ASAE in 1952.

less it be the manufacture of equipment which gives service to users.

The function of the development organization is to examine all the possibilities of creating useful, labor saving equipment and to evaluate all ideas concerned with the specific line of products manufactured.

The thinking of any engineering organization is twofold. It is concerned with both the constant improvement of existing products and the examination of all new lines of approach which may lead to products for the future. During this process, there must be constant cooperation with the financial, sales, and manufacturing divisions so that the final result is the best thinking of the entire organization.

After the design of a product is established and it has been decided to manufacture it, there is a further responsibility for engineering to work with the service and educational departments, because the organization which designs the machine should know more about its function than any other group. This knowledge must be ultimately passed along to the user.

Another function of the design organization is to prepare for the factory organization complete drawings of all details and groups entering into a new product, and, along with the drawings, prepare a complete set of specifications, including every washer, bolt, and cotter pin.

Still another responsibility of the design organization is to develop equipment which avoids patent infringement with existing products and to build into its own products originality which may lead to patent protection.

Type of Personnel Required for Development Work. The key men in a development organization are usually mechanical or agricultural engineering graduates, although there are exceptions. There have been some excellent designers who have studied with correspondence schools or other educational groups not classified as colleges. It is my feeling that anyone who has the courage and initiative to gain knowledge in this way is a rather unusual individual.

In addition to the key men, there are, of course, designers, draftsmen, specification and record personnel, the cost analysis group, and blueprinters.

EXPERIMENTAL DEPARTMENT MANUFACTURES ITS OWN EXPERIMENTAL MACHINES BY HAND METHODS

In our case, we have an experimental organization that manufactures the parts by hand methods for the building of experimental machines from drawings supplied by the engineering department. This organization consists of machinists, welders, sheet metal workers, assemblers, field operators, and test personnel.

In some instances, we place a college graduate in the experimental shop where he gains manufacturing and field experience; in other cases, he is first placed in the drafting room. It is our purpose to round out his experience so he gets design, manufacturing, and field operating knowledge.

The Goal in Product Development. Each particular line of products has some special objectives, but I refer here briefly to harvesting equipment design with which I am most familiar.

Because harvesting machines operate thirty to sixty days a year only, most careful consideration must be given to cost, weight, and strength factors. It is easily possible to overdesign by building into these products wear factors for year-round operation.

At the same time, those products must give capacity performance, they should have low power input requirement, they should have good appearance, and they should have ease of service and simple adjustments. They should be designed so they will be safe for our customers to operate; in fact, we go to some length to guard them against their own carelessness.

I feel designers should strive for distinctive appearance and original features in their products, and, at the same time, they should make every effort to give the user the best possible performance for the lowest dollar investment.

How a Product Is Developed and Tested. It is not the purpose of any farm equipment company to place in the hands of its users equipment which has not been thoroughly field tested.

In the case of a new development, it is customary to build a limited number of pilot machines. These are run for the maximum number of hours under all possible conditions, many changes are often made, and the machine is again tested. This work sometimes goes on for a period of several years before the product is ready for sale.

The Allis-Chalmers WD tractor and hay baler in operation

In the case of harvesting machinery development, test work must be carried out during the harvest. If you want to know how a cotton picker, corn picker, or a grain harvester works, you have to take it to the field and harvest the crop. Laboratory tests are limited to strength of materials and to production problems.

The harvest season is not long and much work must be done in a short time. There is a great deal of cut and try in spite of technical training, and much of one's education is in acquiring the knowledge of what not to do.

What a Product Engineer Should Know. A good farm machinery engineer should have a rather broad working knowledge of a wide variety of subjects. His college education will give him a fine groundwork, but it takes many years to acquire a thorough understanding of the specific line which he wishes to make his life's work. Obviously the training after college varies somewhat with specialized work.

Generally speaking, the high-grade designer in the farm equipment business must acquire either in or after college a working knowledge of the following things:

He must have a fundamental knowledge of many materials and how to use them to best advantage. He is in a very fortunate position today because he has many more of these materials to select from than designers had even ten years ago.

He should have a fundamental knowledge of mathematics and the strength of materials.

He should know how to apply power transmission through gears, chains, flat and V belts, and universal joints.

He should know something about pattern making and foundry practices.

He should know how to express himself through good mechanical drawings and, still further, through oral and written reports.

He should have a general knowledge of farm equipment and its limitations.

He must know something of machine shop practice, welding, stamping, sheet metal work, forging, and heat-treating.

He should have a fundamental knowledge of production costs because it is essential that he be able to design equipment to the lowest cost method.

He should know something about crops, their characteristics, and their yields.

Sooner or later, he will have to know something of patent law and its application.

He will find that actual experience in assembling and disassembling machinery will help him to design a better and more easily serviced product.

Characteristics of a Good Development Engineer. I should like to venture a few of the requirements of a good design or development engineer. The first of these is concerned with work on the drawing board. I have discussed this subject with other engineers in the industry, and we are disturbed about the general attitude of the college graduate toward this work. It is getting to be a rather rare thing to find a man who does not object to board work although he has declared himself interested in design. I know of no other means of designing a product than through careful analysis on the board as the design progresses. If the product has been properly developed, consideration has been given not only to function but to cost and manufacturing as well. There are no quick methods to this end. We are not interested in engineers who object to this kind of a program.

It seems to me that a good designer would wish not only to lay out his work on the board, but to follow it through the laboratory and through its field testing. All of our engineers are trained this way.

Certainly original thinking is an excellent characteristic of a good product engineer. The resultant ideas must withstand criticism, and it must be possible to mould them into a satisfactory workable tool.

The product engineer should not be afraid of failure. Any unusual developments are liable to prove troublesome, and it is the final result that counts. A progressive company expects this.

A good product engineer will not hesitate to develop ideas of others if they are good ones. American industry has been built through ideas which come from all sources; many good suggestions for farm equipment have come from farmers.

Meticulous attention to detail is an important characteristic of a good designer. One weak part can ruin the function of an entire machine.

An engineer should be willing to cooperate, but should never be a yes man. However, he must maintain an open mind because many times he will be wrong.

An engineer must be willing to accept criticism as part of his work. This will come from the user, the manufacturing organization, and the sales organization, and he must be able to distinguish between what is just and unjust. If numerous comments are unfavorable to the product, he had better do something about the design.

THE PRODUCT ENGINEER MUST HAVE A SENSE OF HUMOR

A good product engineer must have a sense of humor. There are times when the going will be tough, and there is nothing more tragic than an engineer who feels sorry for himself.

Another characteristic that he must acquire is the ability to evaluate objectives and to know when these objectives have reached the point where the product is saleable. No design is the ultimate.

Finally, he will have to know that there is no substitute for hard work, that there are no short cuts to success, and that his rewards are in proportion to his service to his company and the users of the company's products.

Why a College Education. The purpose of a college education is to help the graduate engineer develop the following characteristics:

The first is a trained mind with the ability to think, to classify facts, and to learn where knowledge can be obtained.

The second is a technical education which includes mathematics, mechanisms and mechanical motions, application of materials to product design, strength of materials, expression through engineering drawings and machine design, and self-expression through speaking, letter writing, and the ability to make technical reports.

The third is to broaden his general outlook and to develop a scientific approach to a problem.

The fourth is to develop study habits and the orderly use of time.

The fifth is to develop confidence without egotism and to learn something of the dignity of work.

The sixth is to develop an imagination and an inquiring nature.

Experience and Its Teachings. This month it has been my privilege to have been associated with farm equipment design for forty years. Many of these years were spent working on the drawing board, others in the factory, and some in sales. I have found these years most satisfactory.

If there are any conclusions to be drawn from the past, it is the certainty of change. Because of better facilities with which to work today, changes will probably come much faster in future years.

Many pet theories have been thrown out, some formulas have proved to be inadequate, and the colleges haven't always been right. Many things have worked although theoretically they shouldn't; others haven't worked although theoretically they should.

In the farm equipment business, the old steam engine and exposed-gear tractors have almost completely been replaced by the modern and efficient all-purpose gas tractor. The binder is almost extinct, and the stationary grain thresher manned by at least eight bundle teams, two extra pitchers, and two additional operators has been replaced by the combine harvester.

Within this period, the electric light, telephone, automobile, airplane, radio, television, business machines, atomic bomb, and many other developments have come about.

The Challenge for the Future. I am certain that the design and development of better farm equipment carries a distinct challenge for the engineer of the future. There is certainly room for improvement in present equipment, and new types of farm tools will find their way into the picture.

Some of the things which should be given attention are simplification of farm machines, reduction in size and more versatility in tools, quieter running units, safer machinery, reduction in weight, reduction in power input requirements, units which require less lubrication attention, more comfort for the operator, and more simple controls.

The development of these tools should prove to be a fascinating experience and a most satisfactory way of life for qualified engineers.

Why "Agricultural Engineering"?

IT IS well that we have chosen the term "agricultural engineering" for our work. Rural engineering would no doubt be quite satisfactory, but *rural* is not as comprehensive a term as *agricultural*.

. . . .

I think it best to establish well the term "agricultural engineering," and in so doing we will accomplish much toward securing the proper recognition for our work. I can see little value in the argument that engineering is a term confined to the older established branches. Agricultural engineering is as truly an engineering branch and I defy anyone to construe any true definition of engineering to prove the contrary. . . . I have had the pleasure of conversing with several eminent engineers who expressed their conviction of a very bright future for agricultural engineering. Agricultural engineering as yet is not developed to the same point as other older established branches, and the man who cannot see farther than the present can find plenty of opportunity for criticism.

If our new society is to fill its proper place at all, it will be able to offer much more to its members than all of the older societies put together, if it were possible for one to be a member of them all. Engineering has become such a complex subject and has reached such a high stage of development in the older branches that agricultural engineering is practically excluded. Consult, if you will, the proceedings of the societies and see what a small part of the total will apply to agriculture. Then the agricultural engineers' society should have a future because its field is in need of development and is not well covered at the present. — *From the first ASAE President's Annual Address, by J. B. Davidson, December, 1908.*

Fertilizer Placement Affects Sugar-Cane Yields

By M. A. Lugo-Lopez and M. B. Martinez

THE beneficial effects of deep tillage in promoting better soil internal drainage and aeration are unquestionable when dealing with soils which are underlain by claypans, hardpans, or plowpans at relatively shallow depths (1, 2, 4, 7)*. Improved drainage and aeration will lead to more extensive and deeper root systems, and hence crop plants can avail themselves of larger soil volumes in their search for moisture and mineral nutrients. When subsoils are fertile or moderately fertile, the additional availability of nutrients and moisture might prove helpful for crop development. However, the fertility level and subsoils is generally rather low (3). Thus plant nutrients must be supplied at lower depths as well as on the surface soil in order to provide an adequate medium for plant growth. This paper is a progress report of the effects of subsoil shattering and fertilization on the yields of the first sugar-cane crop.

The area selected for establishing the first tillage test is located in Colonia Preston, a large sugar estate of east-central Puerto Rico owned and operated by the Eastern Sugar Associates, one of the largest sugar concerns of the island. Land preparation was started on October 11, 1950, by passing a disk harrow twice to cut the sod. From November 8 to 15 the land was plowed and harrowed three times with disks to a depth of about 12 in. Furrows were made every 5 ft. Surface drainage was provided by ditches every 25 ft at right angles to the furrows and leading to larger drainage ditches dug to follow the topography of the land (Fig. 1).

In one treatment a 18-8-12 fertilizer was applied to the subsoil at the rate of 1,000 lb to the acre. In a second treatment an application of limestone at the rate of 1,000 lb to the acre, as indicated by lime requirement tests, was made in addition to the fertilizer, at the subsoil breakpoint (6). In both cases a second application of fertilizer at the rate of 1,000 lb to the acre was made at the topsoil. In a third treatment, all the fertilizer was applied at the topsoil. Each treatment was replicated nine times. Cane variety POJ 2878, standard for the region, was planted from February 7 to 21. The plant crop was harvested on April 21 to 26, 1952.

For these treatments an International TD-9 diesel, track-type tractor, wide-tread model (60-in width center to center of tracks), 16-in track shoes, heavy-duty equalizer spring, with extended tracks and track frame, was used (Fig. 2). A hydraulic system to operate the International-Universal tool bar (basic) was directly connected to the tractor. The tool bar floated and was hinged for horizontal movements. On this bar was mounted a heavy-duty standard with subsoil point with a removable mole attached. A fertilizer attachment for subsoil was mounted so as to be motivated by the tractor's power take-off which stopped automatically when the tool bar was in the raised position for turning and transporting the tractor; it started automatically when the tool bar was lowered. The standard was graduated so that the subsoil point would penetrate 30 inches.

TABLE 1. MEAN SUGAR YIELDS FOR EACH TREATMENT AT TILLAGE EXPERIMENTAL FIELD ON EAST-CENTRAL PUERTO RICO

Treatments	Sugar yields
All fertilizer on topsoil	9,100 pounds per acre
Half of fertilizer at subsoil	10,800 pounds per acre
Half of fertilizer at subsoil plus lime	10,900 pounds per acre

Statistical analysis of the results (Table 1) of this study reveal that this method of applying fertilizer to the subsoil increased sugar-cane yields from 15 to 19 per cent (5). Even when the increased power and labor that subsoil fertilization will demand, and the harvesting and hauling costs that the extra tonnage will mean are considered, the sugar cane grower will obtain a larger net profit than when fertilizing only the topsoil.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The authors: M. A. LUGO-LOPEZ and M. B. MARTINEZ, respectively, associate soil scientist and research assistant in agricultural engineering, Puerto Rico Agricultural Experiment Station.

AUTHORS' NOTE: The authors acknowledge the cooperation in the preparation of this report of R. L. Blasingame, visiting agricultural engineer, Puerto Rico Agricultural Experiment Station.

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Fig. 1. The plots used were 200 ft long by 20 ft wide to facilitate the operation of the heavy equipment necessary.

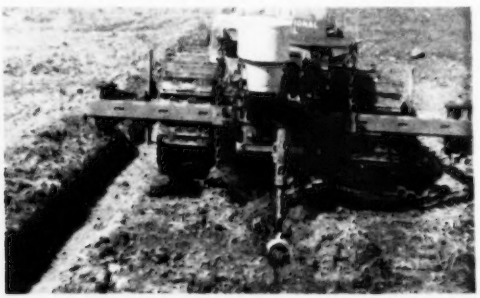

Fig. 2. This shows the International track type tractor, tool bar, fertilizer distributor, and mole ready to enter the ground.

Factors Affecting the Wind Resistance of Asphalt Shingles

By Merle L. Esmay and Henry Giese
MEMBER ASAE FELLOW ASAE

WIND damage to asphalt shingles on farm buildings in Iowa has steadily increased during the last twenty years, during which time wind-loss-experience studies have been made by the Iowa Agricultural Experiment Station (2)*. The damage to asphalt shingles has increased from 11.1 per cent of the total roofing damage in 1930-33 to 64.5 per cent in 1946-48, or nearly six times within twenty years. The seriousness of this increase of asphalt shingle damage is emphasized by the findings of a roofing survey by the Iowa Agricultural Experiment Station in 1948 (1), which found that only one-eighth of the area of all farm building roofing in Iowa was of asphalt shingles. This indicates that on a weighted basis, area for area, the probability of wind damage to asphalt-shingle roofing on Iowa farm buildings was 18.1 times greater than for damage to wood-shingle roofing.

On a dollar basis these damages to asphalt shingles on Iowa farm buildings as recorded from the loss experience of the Iowa Mutual Tornado Insurance Association amounted to $55,276 in 1947 and for one windstorm on October 10, 1949, to $137,883. The damage from the single windstorm was over two and one-half times as high as for any previous year. It might be argued by some that this was an extremely severe storm which would happen only once in a period of fifty or a hundred years; however, the very next year, on May 5, 1950, there was another general cyclonic-type windstorm in the Midwest which caused more than four times as much damage as the 1949 storm. The actual loss to the farmers, not including the inconvenience, amounted to another 50 per cent of these amounts, inasmuch as one-third of the expected life of twenty years had already been used, for which he was not paid. Moreover, these figures do not represent all damaged shingles, as many are not insured or are covered by other companies.

Inasmuch as field observations showed that wind damage to tab-type asphalt shingles was caused by the continuous flapping or bending of the shingles, until eventually the tab broke off or the shingle tore past the nails, a similar controlled bending test in the laboratory was designed to measure the comparable wind resistance of various tab-type shingles. Field studies of asphalt shingles by Cleveland (1) showed that good asphalt shingles were 10 per cent thicker than damaged asphalt shingles and that they had 0.63 in less exposure. From these and other observations, it is quite evident that wind resistance of asphalt shingles is a function of both the shingle design and its application. With this in mind, an experiment was designed to determine the extent to which the various ingredients of tab-type asphalt shingles contribute to its wind-resisting qualities, as well as the effect of the number of nails, the nailing distance from the lower edge of the shingle, and the temperature level. It was also desired to compare the wind-resisting ability of the thick-butt and uniform-thickness types of asphalt shingles.

One bundle of each of 27 different tab-type asphalt shingles was procured from retail stores for testing. The 27 types of shingles represented are products of fourteen different manufacturers. Seven of the 27 shingle types tested were of the hex-tab design of which one was a three-tab, rounded-tab type, one a two-tab type and the remainder three-tab types. Six

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The authors: MERLE L. ESMAY and HENRY GIESE, respectively, formerly assistant professor of agricultural engineering and professor of agricultural engineering, Iowa Agricultural Experiment Station.

*Numbers in parentheses refer to the appended references.

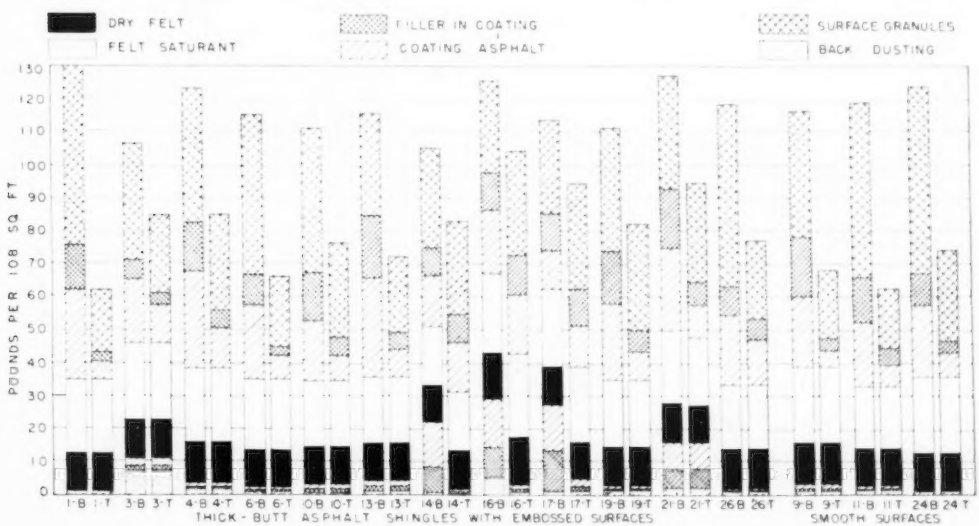

Fig. 1. Composition of new thick-butt asphalt shingles.

shingles were of the square-tab uniform-thickness design. One shingle was a tapet-type 10-in tab design. Fourteen of the twenty-seven shingles were square-tab thick-butt types all of which were the 12-in tab design except two. These were 10-in shingles designed for 4-in exposure, one of which was a four-tab design.

The procedure of the experiment was to determine the composition of the various makes and types of asphalt shingles and then to subject them to physical bending tests under varying conditions of nailing patterns and temperature.

COMPOSITION ANALYSIS

It has been generally assumed that the weight of felt in an asphalt shingle plays a large part in determining its wind resistance and durability; however, to what extent has never been determined through controlled tests. Also, the filler in the bitumen coating, used as an extender by many manufacturers, has been thought to be a weakening factor in bending resistance.

The chemical analysis of asphalt shingles in general involved the breakdown of the shingle ingredients into the three basic materials: felt, bitumen, and mineral. The analysis in more detail included the quantitative determination of the felt saturant bitumen and coating bitumen separately, as well as the difference between granule mineral on the top surface, the back coating mineral, and the filler mineral in the coating bitumen. The protective coating bitumen is of a more viscous nature with a comparatively higher melting point than that used for saturating the felt. This coating may be of pure bitumen or, as in many shingles, a mixture of bitumen and various amounts of fine mineral filler. The total mineral matter is made up of these parts: (*A*) the above-mentioned filler, designated as that which passes through a 100-mesh screen, (*B*) the top-surface granules generally of natural slate or crushed materials treated with pigments or ceramic materials, and (*C*) some type of back dusting, consisting generally of mica dust or fine sand.

In general the laboratory method used for analyzing the asphalt shingles was patterned after procedures outlined in Federal Specifications SS-R-521, entitled "Roofing and Shingles: Mineral Surfaced, Asphalt Prepared" (*11*). Some alterations were made to adapt the procedure to the equipment available for this study and in some cases to increase the accuracy of the analysis. Carbon disulfide (CS_2) was used for the solvent in this analysis to extract the soluble bitumen from the remainder of the shingle constituents. Three-inch Soxhlet extractors with pyrex glass evaporating flasks and condensers were used for this analysis in lieu of the metal New York Testing Laboratory-type extractors which were not available.

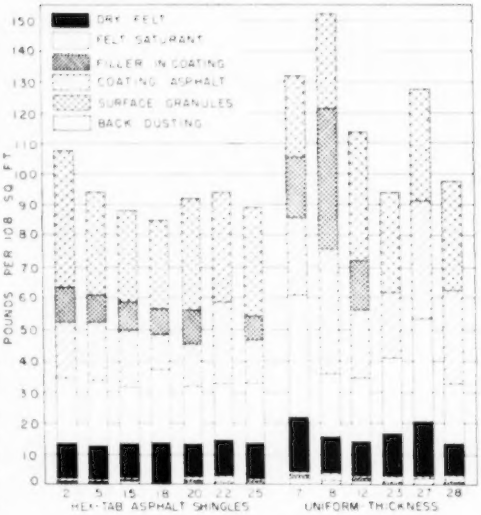

Fig. 2 Composition of new asphalt shingles

For the analysis, representative 2-by-3-in samples were taken from each bundle of shingles in sufficient number so that duplicate data were obtained in all cases. The test samples were cut with a die from two strip shingles chosen at random from the bundle and then weighed. Only those samples which agreed with predetermined weights of 2-by-3-in areas of that particular shingle were used. After analyzing the composition of the 2-by-3-in samples the weights of all ingredients were projected to a 108 sq ft basis.

FINDINGS OF COMPOSITION ANALYSIS

Fifteen different shingles with varying cross sections were originally analyzed; however, one shingle (No. 6) was ana-

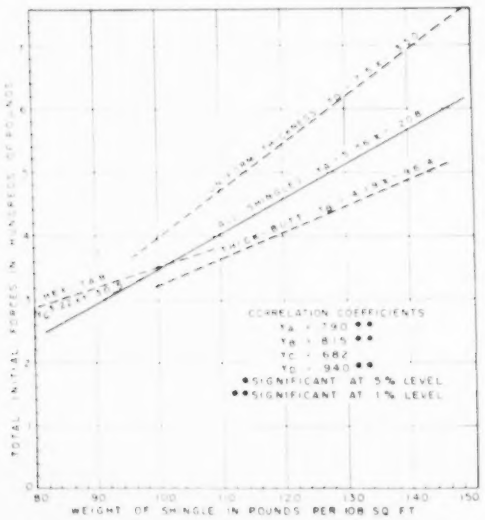
TOTAL INITIAL FORCES IN HUNDREDS OF POUNDS
WEIGHT OF SHINGLE IN POUNDS PER 108 SQ FT
CORRELATION COEFFICIENTS
YA = .790 **
YB = .815 **
YC = .682
YD = .940 **
*SIGNIFICANT AT 5% LEVEL
**SIGNIFICANT AT 1% LEVEL

Fig. 3 Correlation of initial bending forces of asphalt shingles with total weight

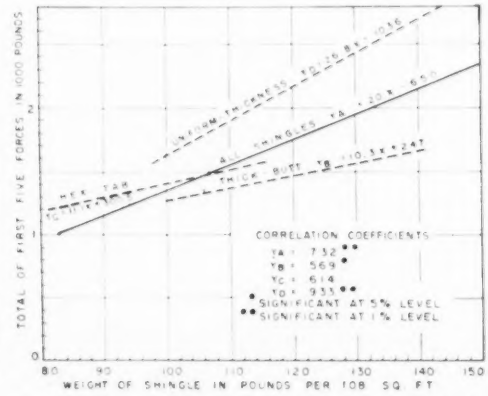
TOTAL OF FIRST FIVE FORCES IN 1000 POUNDS
WEIGHT OF SHINGLE IN POUNDS PER 108 SQ FT
CORRELATION COEFFICIENTS
YA = .732 **
YB = .569 *
YC = .614
YD = .933 **
*SIGNIFICANT AT 5% LEVEL
**SIGNIFICANT AT 1% LEVEL

Fig. 4 Correlation of total of first five bending forces of asphalt shingles with total weight

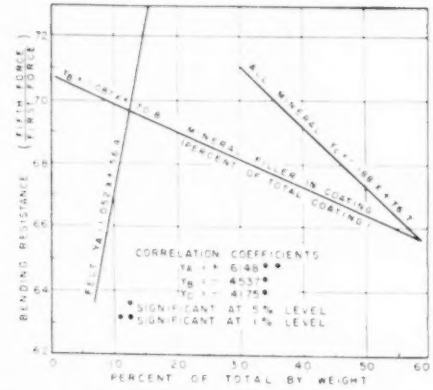
BENDING RESISTANCE (FIFTH FORCE / FIRST FORCE)
PERCENT OF TOTAL BY WEIGHT
% CRITERION
% MINERAL FILLER IN COATING (PERCENT OF TOTAL COATING)
% MINERAL FILLER
CORRELATION COEFFICIENTS
* SIGNIFICANT AT 5% LEVEL
** SIGNIFICANT AT 1% LEVEL

Fig. 5. The effect of felt weight, mineral filler and total mineral upon continued bending resistance.

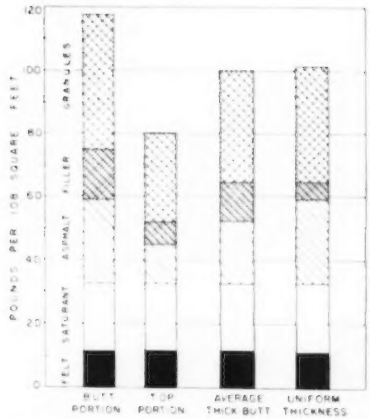

Fig. 6. Average composition of 14 thick-butt and three medium weight, uniform-thickness shingles.

lyzed for composition only so it has not been included in the following discussion of results. Fig. 1 presents graphically the composition of these shingles in pounds per 108 sq ft. Two vertical bars are shown for each shingle. The taller bar of each shingle represents the thick-butt portion and the shorter the thin-top portion. The proportions of the various ingredients are shown by the different cross hatching of the bars. Three of the 14 thick-butt shingle group had smooth surfaces and are shown on the right side of the graph, while the remainder of the thick-butt shingles were all of the embossed surface type.

The composition analysis of the thick-butt shingles shows a considerable variance in the composition of the different shingles. Shingle No. 1 had a thin top of less than one-half the weight of the butt on a unit area basis. Some of the shingles were loaded heavily on the butt portion with mineral granules. The coatings on the backs of the shingles varied from practically nothing in the cases of Nos. 1, 24, and 26 to very thick coatings on the butt portions of Nos. 14, 16, and 17. The filler mineral in the bitumen coatings varied from slightly over 22 per cent of the total amount of coating for shingle No. 3 to slightly over 47 per cent for shingle No. 17. The parts saturant in the felts varied from a minimum of 158 parts per 100 for shingle No. 14 to 204 parts per 100 for shingle No. 17.

Fig. 2 presents graphically the composition of the uniform-thickness shingles tested, both of the square-tab and hex-tab design. The hex-tab shingles appear to be more uniform in make-up, with the exception of No. 22, which contained no filler. Wide variance was found in the composition of the six uniform thickness square-tab shingles, inasmuch as the heavier types of asphalt shingles are of this design as well as some of the lighter ones. Two of these shingles, Nos. 7 and 27, had considerably heavier felts than average, being over 17 lb per 108 sq ft in both cases. On the other hand, shingle No. 28 had only slightly more than 10-lb felt. The parts saturant in the felt of shingle No. 7 was 223 parts per 100. This shingle also had a very high percentage of filler in the coating, being close to 50 per cent. Shingle No. 12 was an average weight shingle; however, it had a fairly high amount of mineral filler, which made up about 42 per cent of the coating. Shingle Nos. 23, 27, and 28 varied mainly from the others in that they had no coating filler. They differed from each other mainly in felt weights and total weights.

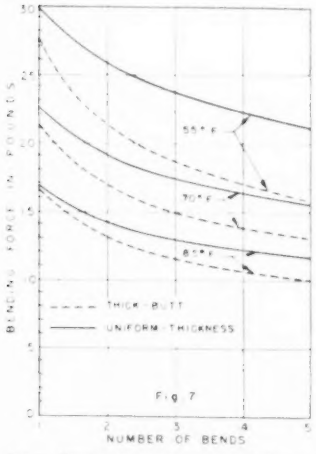

Fig. 7. Bending resistance of asphalt shingles at various temperatures.

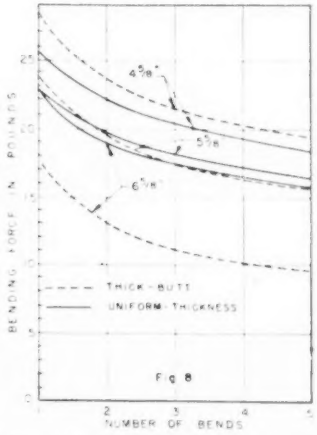

Fig. 8. Bending resistance of asphalt shingles nailed with 6 nails at various nailing distances.

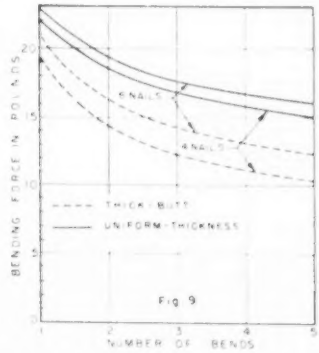

Fig. 9. Bending resistance of asphalt shingles with 4 and 6 nails per strip shingle nailed at 5⅛ and 6⅛-in distances.

PHYSICAL TEST OF ASPHALT SHINGLES

A bending test was designed from which comparative wind-resisting capabilities of asphalt shingles could be measured. With this comparative wind resisting index for a shingle, correlations were made with the composition and type of shingle. The bending resistance index was determined by measuring the initial bending resistance of the strip shingle, as applied with varying nailing patterns and at different temperatures, as well as the resistance to successive bends. The bending force was applied mechanically at a rate of 14 bends per minute and was measured with a spring balance. All three tabs of the strip shingles were bent simultaneously through uniform arcs and returned each time to the horizontal position. The bending was continued with each shingle until no appreciable resistance was offered, and observations of the type of failure were made in each case.

The bending test was designed as a six-by-three factorial experiment. Six different types of nailing patterns were tested at three different levels of temperature. Eighteen tests of each type of shingle were made; that is, one test of each combination of the six by three factorial design. Although this experiment had no absolute replications, each test supplied information upon each of the main questions, which the experiment was designed to examine, and it had the same precision as though it had been devoted to each of the questions alone. It was thereby possible to obtain information not only on the wind resisting characteristics of shingles as related to composition, but also on the effects of nailing at varying heights, using various numbers of nails and at different temperatures.

Information on the important question of number of nails necessary in one strip shingle was desired. In the past the use of four nails has been more customary than six; however, more recently, since the manufacturers have become conscious of wind damage, most specifications call for six nails, placed at a distance of $5\frac{5}{8}$ in from the butt edge for application with the customary 5-in exposure. Inasmuch as field observations have shown that nails are placed anywhere from $4\frac{5}{8}$ in high for the 4-in exposure to $6\frac{1}{2}$ or 7 in high for the 5-in exposure, a range of 2 in in nailing distance was set up for the experiment. Cleveland (1) found in observing 87 damaged asphalt shingle roofs, with 5-in exposures that the average distance of the nails from the lower edge of the shingles was $6\frac{1}{2}$ in.

To cover as nearly as possible the range of field application, the following six nailing patterns were tested: (*a*) six nails $6\frac{5}{8}$ in high, (*b*) six nails $6\frac{1}{2}$ in high, (*c*) six nails $5\frac{5}{8}$ in high, and (*d*) six nails $4\frac{5}{8}$ in high, (*e*) four nails $6\frac{5}{8}$ in high, and (*f*) four nails $5\frac{5}{8}$ in high. The levels of temperature at which these tests were run were 55, 70, and 85 F.

CORRELATION OF BENDING BEHAVIOR WITH COMPOSITION OF ASPHALT SHINGLES

Laboratory data and field observations indicated that the heavier shingles performed the best against bending stresses. Correlations were, therefore, made between weight of shingles and the initial bending resistances. Also, correlations were made between weight of shingles and the totals of the first five resisting forces. Figs. 3 and 4 illustrate with solid black lines the linear regression lines along with the regression equations for the total of the 27 shingles tested. The coefficients for these over-all correlations were found to be highly significant for both the initial forces and the totals of the first five. It may be noted, however, that the correlation for the totals of the first five bends was somewhat lower than for the initial bends. This indicates that something other than mere weight plays a part in continued bending resistance of asphalt shingles.

In plotting the points for the over-all regressions, it was noted that the points for the three different types of shingles fell in distinct groups. Separate correlations were then calculated and the respective regression lines were plotted on Figs. 3 and 4 as broken lines. These individual correlation coefficients indicate also that weight is more significant in affecting initial bending resistance than continued bending resistance. The least difference is noted with the uniform-thickness shingles, the correlation coefficient being significant at the 1 per cent level in both cases. The hex-tab shingles were so few and the results so diverse that this group was not significant even at the 5 per cent level in either case. The correlation coefficient for thick-butt shingles was highly significant for initial resistance, but significant only at the 5 per cent level for continued resistance. This indicates weight alone increases the continued resistance of such shingles much less than for the uniform-thickness shingles.

To determine what the continued bending resistance of asphalt shingles is dependent upon, simple correlation coefficients were obtained between the per cent of the initial bending resistance remaining after five bends and the following dependent variables: (*a*) per cent of filler in the coating, (*b*) per cent of felt by weight in the shingle, (*c*) per cent of total bitumen by weight in the shingle, and (*d*) per cent of total mineral by weight in the shingle. The coefficients are as follows:

$r_1 = 0.4537$ (significant at the 5 per cent level)

$r_2 = +0.6148$ (significant at the 1 per cent level)

$r_3 = +0.3027$

$r_4 = 0.1175$ (significant at the 5 per cent level)

From these coefficients it is evident that the effects of the felt weight is the most highly significant. Linear regression lines for the three significant variables are plotted in Fig. 5. The highly significant regression line representing the portion of felt is very steep because of the narrowness of the range in portion of felt from 7.5 to 14.5 per cent found in the shingles and the large effect of a one per cent increase in felt weight. The range in the proportion of mineral present ran from 30 per cent up to nearly 60 per cent, and in contrast to felt, additional mineral decreased the continued bending resistance of the shingles. It was also found that the mineral filler in the asphalt protective coating of the shingle had a weakening effect which was significant.

ANALYSIS

In order to determine the significance of the effects of specific nailing patterns, as well as the various temperature levels on bending resistance, an analysis of variance of the factorial data was made for each type of shingle studied. Standard errors of individuals, treatments, types, and levels were calculated from which the significant differences were determined from the *t* values taken from table 5.8 of Snedecor (3, p. 65). Because of the wide variance in performance between the thick-butt and uniform-thickness shingles, the analysis was made separately in all cases. For brevity of presentation in this paper, the following analysis pertains mainly to a direct comparison between these two types of shingles. All of the significant findings are brought out with this comparison.

As illustrated by Fig. 6, it was found that the average composition of the fourteen thick-butt shingles studied was as shown by the two bars on the left. The average total weight of the thick-butt portions of the shingles was 117.8 lb per 108 sq ft, and for the top portions it was 80.1 lb. Based on the findings that the thick portions of these shingles made up 52.3 per cent of the total area, the total average weight of an equivalent uniform-thickness basis was 99.8 lb per 108 sq ft. This equivalent composition is illustrated in Fig. 6 by the single bar next to the one on the right. The right-hand bar represents the average composition of three medium-weight uniform-thickness shingles which were chosen from the seven tested, because their total composition averaged very nearly the same as that for the thick-butt shingles.

It is noted from Fig. 6 that not only was the total average uniform-thickness equivalent weight of the thick-butt shingles nearly the same as the average for the selected three uniform-thickness shingles, but also that the amounts of the various ingredients were nearly the same with the exception of the protective coating. Also, the total amounts of the protective coatings were nearly the same. The difference was in the amount of mineral filler, the thick-butt shingles having 57.8 per cent and the uniform thickness shingles having only 17.2 per cent.

(Continued on page 556)

A 20-Year Appraisal of Engineering Practices in Soil and Water Conservation

By Dwight D. Smith
MEMBER ASAE

WATER-DISPOSAL systems that will carry excess precipitation from the field to the creeks and rivers without gully formation have been developed. The farm owner or operator, however, is frequently reluctant to apply all the parts of a complete system. He may, without considering future benefits, object to terracing because of the time and effort of farming the land once it is terraced in the conventional manner. He may object to the cost of a structure or dam considered necessary for drainageway stabilization. Water-disposal systems frequently cost more per acre than basic soil treatments and do not give the immediate return in increased crop yields that are secured from application of these soil treatments. Development of more economical systems would do much to speed conservation of soil and water, the first requirement for soil improvement.

Basic factors affecting soil and water loss and development of methods for conservation of soil and water were investigated at the Soil Conservation Experiment Station, Bethany, Mo., 1930 to 1945. Since that time the farm has been operated by the owner under a conservation farming plan. Periodic appraisals were made through 1951 of the conservation practices and structures. The results of these appraisals have been included in a new summary report of the station work to be published as a U.S. Department of Agriculture technical bulletin. This paper will deal with the appraisals of those practices and structures that are included in a water-disposal system.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Soil and Water Division. It is a contribution of the cooperative project, Midwest Claypan Soil Conservation Experiment Farm, McCredie, Mo., U.S. Department of Agriculture, Soil Conservation Service, and has been approved by the director of the Missouri Agricultural Experiment Station as Journal Series Paper No. 1515.

The author: DWIGHT D. SMITH, research project supervisor, Soil Conservation Service, U.S. Department of Agriculture, Columbia, Mo.

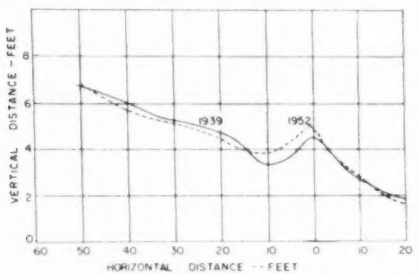

FIG 1. Plowing of terraced fields with the conventional plow, with which half of the furrows are turned downslope, results in benching and an accumulation of top soil on the front slope of the terrace ridge.

TERRACING

The terraced fields that were plowed after 1945 are showing definite evidence of benching. The three plowings in this period have been by a conventional gang plow. With it half of the furrows were turned downhill. This bench development is shown in Fig. 1 by the differences in the 1939 and 1952 terrace cross sections. These are composite cross sections of terraces of normal spacing on a field of average slope (8 per cent) and normal soil depth. The terraces on this field have decreased less in size than on other fields of the farm that have a steeper land slope and that have suffered more erosion.

The 1952 cross section shows that the terrace ridge has become more peaked, largely through steepening of the terrace back slope. The top channel width has shown the greatest dimension change. It was 17½ ft in 1939, and at the time of the survey in 1952 it was 28 ft. There has been a movment of soil down slope from the area immediately above the channel. Most of this soil has accumulated on the terrace front slope.

Between 1935 and 1945 the experiment station terraces were plowed by a two-way plow. With this plow it was possible to turn all furrows up slope, leaving the deadfurrow in the terrace channel. This method of plowing in the regular farming operations eliminated the need for terrace maintenance. Plowing was at intervals of 2 or 3 years.

The two-way plow used on the station was a trailer type with two sets of 14-in gangs. The right and left-hand gangs were mounted adjacently on a wide frame. The frame of the plow was too wide for satisfactory plowing in the channel and on the ridges of terraces on the steeper slopes. Side draft and lack of a drawbar shift lever were also objectionable features. Elimination of terrace maintenance and the more uniform surface soil depth and slope maintained between terraces were considered more than ample compensation for the minor difficulties encountered with the two-way plow. Fig. 2 shows a tractor-mounted, two-way plow which does not have the disadvantage of the wide-frame plow.

The upslope movement of soil in most cases compensated for the downslope movement from erosion and machinery operation. For an average land slope of 8 per cent, this upslope movement of soil by one normal plowing was calculated to be from 18 to 25 tons per acre, depending upon the horizontal spacing of the terraces. Despite all the apparent advantages of two-way plows, they have not received widespread acceptance by farmers.

FIG 2 (*Left*). Use of a two-way plow on terraced land, with which all furrows are turned upslope, maintains a more uniform depth of top soil over the interterrace area and provides automatic terrace maintenance by moving eroded soil back up the slope. • FIG 3 (*Right*). Sloping of gully banks above a structure and draining of the fill soil by tile lines favors the establishment of palatable species of vegetation that may be harvested for hay, seed, or pasture.

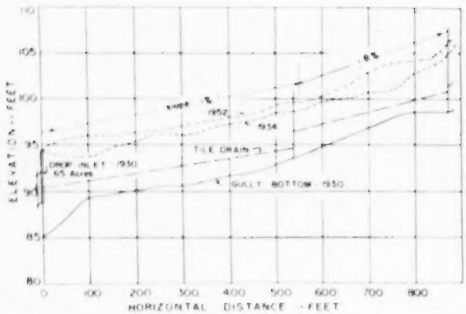

Fig. 4. Drainageway grades have stabilized between 1 to 2 per cent above drop-inlet dams as grass became established. Sloping of gully banks hastened the filling and lessened the side slopes such that haying operations could be carried on. Tiling allowed establishment of palatable species of grass.

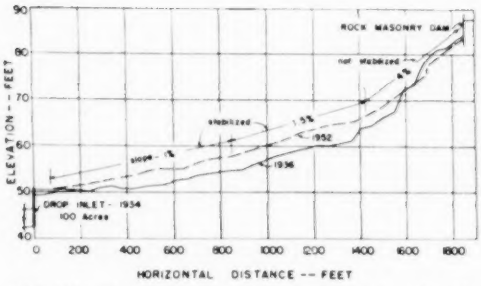

Fig. 5. Stabilized grades developed in the drainageway above drop-inlet dams without bank sloping and tiling, to function as water-disposal channels as satisfactorily as when the banks were sloped and the fill soil drained. There was little economic return since the slough grass that became established was relatively unpalatable.

STABLE WATERWAY GRADES

Two drop-inlet dams were installed on the station, one on a 65-acre drainage area in 1930 and another on a 100-acre drainage area in 1934.

The gully banks were sloped above the first drop inlet, and a tile line installed in the fill soil during 1933. The purpose of the tile was to drain the soil and encourage desirable types of vegetation. Timothy and bluegrass became well established on this fill material in a few years. At present, bluegrass predominates. This drainageway has been relatively easy to mow. It has produced timothy seed and hay and now furnishes pasture for livestock. Fig. 3 shows harvesting of hay in 1937.

By 1939 a stabilized grade of 0.7 ft per 100 ft had been established for approximately 750 ft above the structure. By 1952 the grade increased to 1.0 ft per 100 ft for the first 550 ft and to 1.8 ft for the next 800 ft. The 1930, 1934, and 1952 profiles are shown in Fig. 4.

A tile line was not installed and the gully banks were not sloped above the drop-inlet dam installed in 1934. Slough grass soon became established in the silt deposited in the gully immediately above the pond. Subsequent deposition resulted in development of a relatively flat bottom section between the gully banks that now extends 1,400 ft up the drainageway. The grade for the first 800 ft is 1.0 ft per 100 ft, and for the next 600 ft, 1.5 ft. Above this point, for a distance of 400 ft the grade is 4 ft per 100 ft and not stabilized. Profiles of the drainageway in 1936 and in 1952 are shown in Fig. 5.

This drainageway remains wet for rather long periods each year, making crossing with farm equipment hazardous. The gully banks also are too steep and irregular for mowing. The vegetation is unpalatable, and thus there has been little economic return from the drainageway, although it is included in a pasture area. However, it has served the function of a stabilized channel for water disposal as satisfactorily as the waterway with the sloped banks and tile drain.

STRUCTURES FOR STABILIZING DRAINAGEWAYS

The problem of drainageway stabilization on the station was divided in general according to size of drainage area. Field drainageways for contour and strip-crop areas and outlets for terrace systems were considered adapted to stabilization by vegetation alone. The drainage areas were generally less than 12 acres in size. Advancing overfalls in the larger drainageways were considered a problem to be solved by structures or dams.

The important principle of drainageway stabilization developed from the work on the station is that wise land use and the application of practices for reducing soil and water losses from the fields are the first steps toward control or elimination of gullies. These practices operated to alleviate the causes of gully formation. Their application resulted in sufficient reduction in rate and amount of runoff to reduce appreciably the difficulty of drainageway stabilization.

Temporary Dams. For the first few years there was an intermediate-sized area in which temporary check dams of brush, wire, and posts were utilized for temporary stabilization until grass was established. Experience proved them of little value, if any. They caused additional turbulence, which prevented complete establishment of the grass, and they required yearly maintenance to function as overfall structures. Maintenance of all such structures on the station ended in 1943. By 1951 all had become ineffective, leaving the drainageway in an unstabilized condition, except for two 2-row post dams. Here the brush had rotted but had been replaced by grass that was growing both above and below the structures. This represented successful functioning of less than 5 per cent of the total number of such structures that were installed.

Weir-Notch Drop Structures. Structures to drop the runoff water from 2 to 5 ft in drainageways carrying runoff from areas of 20 to 40 acres were constructed of reinforced concrete, rock masonry, and creosoted lumber. The creosoted plank structure was relatively low in first cost and easily installed. Its life, however, was only 15 years since the creosote was applied by hot dipping and not by pressure treatment. The rock masonry dams are in excellent condition after 17 years of service. They have not required maintenance. The larger of the two, with a drop of 5 ft, is an upstream arch type. The wall thickness varies from 8 to 10 in. They are durable structures for sites where it is necessary to maintain a permanent drop of 3 to 6 ft in the drainageway, and are practical where rocks are readily available on the farm. Their life is estimated to be 40 years. The reinforced concrete dam is a toe wall at the end of a terrace outlet. The drop is 2 ft, and the wall is 4 to 5 in thick. There are no cracks or other signs of deterioration after 15 years' service.

Fig. 6. Unformed concrete flumes are an economical and satisfactory mechanical means of reducing the grade in water-disposal channels. They are susceptible to damage by burrowing rodents. The flume in the foreground was installed in 1942.

Fig. 7. Use of an auxiliary spillway for a detention reservoir is sufficiently infrequent for damage that may be caused by large runoff storms to be repaired by natural growth of the grass. *(Left)* Grassed gully bank (left) to be used for this purpose, in 1936 at the time the dam was constructed. *(Right)* The same gully bank in 1952

Flumes. Flumes were constructed of sheet metal, thin-section concrete, and sand-asphalt mixtures. The sheet metal and concrete flumes were undermined by rodents and later by runoff water from the drainage area above. This caused failure of one of the sheet metal flumes in 3 years and of the other in 8 years. The latter flume could have given additional service if it had been re-installed. One 2-in-thick concrete flume lasted 5 years. The other two, of thicker concrete, were in place in 1952 and with limited maintenance could give many additional years of service. The two flumes, about 50 ft apart in the same drainageway, are shown in Fig. 6.

The flume in the foreground is the original of the Missouri type unformed flume. It was designed and installed by A. T. Holman in 1932. Maintenance has consisted of placing a masonry toe wall under the apron end in 1937 and asphalting the cracks. Most of the cracks occurred during the first 5 years as the absence of a toe wall allowed under-cutting and settling. The flume has a drop of 5 ft. The concrete is about 6 inches thick and was reinforced with fence wire. Rodent burrows in recent years have resulted in a small flow under the flume which could easily be repaired by floating in a silt and sand mixture. If repaired, the structure would easily last an additional 10 years.

The flume in the background of Fig. 6 was constructed in 1937. It has a U-shaped drop entrance. It was constructed in seven independent units to eliminate breaks from frost heaving. The bar and wire reinforced concrete was 3 to 4 in thick. The lower section is an energy dissipator shaped to throw the water upward and outward. The flume has given satisfactory service until the last year, when rodent burrows allowed runoff to pass under the cutoff walls. The extent of the burrows is shown by the dark area at the right of the flume in Fig. 6. There are no cracks in the concrete.

The sand-asphalt flumes failed in 10 years, 2 years after annual maintenance ended. The material was hot mixed and tamped in place 3 to 4 in thick. Failure first occurred at the apron section, where the direction of the flow was changed.

Fig. 8. Grasses such as reed canary grass that spread from natural seeding and creeping rhizomes show possibility for stabilizing many overfall gullies that in the past were considered controllable only by structures. This 18-ft overfall gully was stabilized by natural spreading of the grass from a seeding in the drainageway above

Drop-Inlet Dams. The drop-inlet dam on the 65-acre area was constructed in 1930. It has given satisfactory service for 22 years, although the bottom of the 36-in corrugated metal tube has small pit holes that extend through the metal. Without repair, its life will probably be not more than 8 additional years, a total life of 30 years. The 4.5-ft riser is of concrete and has a cross-section area 50 per cent greater than the tube. The tube drops 4.7 ft in its length of 50 ft. Originally the discharge end was 2 ft above the gully bottom. This has increased to about 5 ft and required the installation of a concrete discharge section in 1937.

The second drop inlet, in a drainage area of 100 acres, was constructed in 1934. The spillway was a reinforced concrete box culvert 4-by-4 ft with an 8-ft riser. It was constructed according to standard specifications in use at that time for such structures. By 1951 a 1/16-in-wide crack had developed across the bottom of the barrel in the center of the dam. The crack extended up both sides and ended near the top of the barrel. Otherwise the structure was in excellent condition. Its estimated life is at least 40 years.

Detention Reservoir Dams. A detention reservoir dam was constructed on a 35-acre drainage area in 1936. A 12-in-diameter vitrified-clay sewer tile was used for the mechanical spillway. A concrete elbow on the upper end of the tile line and a masonry headwall comprise the entrance section. The discharge section is a rock-masonry well with an open segment so placed that water from the tile circulates before discharging into the waterway below. The structure controls a drop of 14 ft. The earth fill was constructed at the edge of the gully overfall with a top width of 6 ft and 1½-to-1 side slopes. The auxiliary spillway emptied on a grassed area below the dam and re-entered the gully over the steep though grassed left bank of the gully shown in Fig. 7 (left view).

The auxiliary side spillway was located 4 ft above the tile entrance. This provided detention storage of 3.7 acre-feet, which was equivalent to 1¼ in of runoff from the drainage area. The original design was based on use of the auxiliary spillway once in 5 years. In the 16 years that the structure has been in service the auxiliary spillway has apparently been used only a few times. Any damage that may have occurred where the water re-enters the gully has been repaired by natural growth of the grass. Fig. 7 (right view) shows this location in 1952.

A discharge test under a falling head was made by A. W. Zingg in 1939. The discharge rate was determined from a water-level-recorder record secured during the test and a stage-volume curve. The tests indicated a discharge of 19 cfs with a 4-ft head over the tube entrance. This decreased to 15 cfs when the head dropped to 2 ft, and to 9 cfs when the head was one foot. The capacity of the tube to carry runoff under a 4-ft head on the entrance is 22 per cent of the calculated 10-year frequency rate of runoff.

The tile line, entrance, and discharge sections are in excellent condition 16 years after installation and are estimated to have a total life of 35 years. The earth fill, however, has numerous rodent burrows which with the narrow top of the dam could give serious trouble should a storm of 25 years or greater frequency occur before repairs are made.

An analysis of structure costs on the experiment station revealed this structure to have the lowest cost per unit of pro-

tection. Costs included material and labor of installing the mechanical spillway and actual and anticipated repairs. A unit of protection for a structure was considered as the product of vertical drop in feet, total life in years, and drainage area in acres. Costs of the drop-inlet dams were 67 per cent higher and of the concrete flumes and rock-masonry dams 100 per cent higher than for the detention-reservoir dam.

A similar type structure has been installed at the Midwest Claypan Soil Conservation Experiment Farm, McCredie, Mo., and equipped with a waterstage recorder and flume to enable a more detailed study of the hydraulics of this type structure.

Grass for Control of Overfall Gullies. The effectiveness of adapted grass in control of overfall gullies has been revealed by the periodic inspection of the work on the Bethany station. Reed canary grass, a very tenacious species that thrives in waterways when once established, was seeded in the drainageway of a 12-acre cultivated field in the spring of 1944 and 1945. It did not become well established until 1945. It spread downstream, however, and by 1951 had reached a point 200 ft below the station boundary. An 18-ft overfall has advanced up the waterway to a point 75 ft below the fence. In the distance of 125 ft, the overfall has become practically stabilized by the grass such that little, if any, further advance is probable. Apparently clumps of the grass that were loosened at the upper edge of the overfall took root in the wet silt at the base of the overfall, forming a barrier that caught sufficient of the subsequently loosened clumps gradually to form a flume to the waterway above as shown in Fig. 8. Reed canary grass from a seeding made about 1947 has now stabilized another gully on the station. This gully was originally a test site of black locust trees and temporary brush dams for gully stabilization, both of which were unsuccessful.

CONCLUSIONS

Plowing of terraced fields with the conventional plow, with which half of the furrows are turned downslope, has resulted in benching and an accumulation of top soil on the front slope of the terrace ridge. Use of a two-way plow, with which all furrows are turned upslope, maintains a more uniform depth of top soil over the interterrace area and provides automatic terrace maintenance by moving eroded soil back up the slope from the channel.

Stable grades of between 1 and 2 per cent have developed above structures as grass became established in the silt deposits. Sloping of the gully banks above a structure and draining of the fill soil by tile lines favored the establishment of palatable species of grass that were harvested for seed, hay, or pasture. This area thus yielded an economic return although its functioning as a stabilized water-disposal channel was little, if any, superior to that developed without banksloping and without tiling.

Lowest cost protection of all structures used on the station was provided by a detention reservoir dam utilizing a small-diameter tube with a discharge capacity 22 per cent of the 10-year frequency rate of runoff, detention storage, and an auxiliary grass spillway. The next lowest cost was for conventional drop-inlet dams, followed by rock-masonry, weir-notch dams and unformed concrete flumes.

Structures of wood planks, sand-asphalt mixtures, sheet metal flumes and wire-brush-post dams were unsatisfactory. Rodent burrows caused damage under all flumes but not with tube structures.

The use of a tenacious grass, such as reed canary grass, has shown possibility for stabilizing many overfall gullies that in the past were considered controllable only by structures. This grass has proved well adapted to the adverse site condition of large drainageway gullies. Since it spreads both by natural seeding and creeping rhizomes, it provides a more nearly self-maintaining method of gully stabilization than the conventional mechanical structure and at a much lower cost. The upper limits of its adaptability have not been established.

The application of conservation measures that reduce runoff and erosion has proved to be a very important first step in gully stabilization. Development of more practical and economical systems of water disposal would do much to speed conservation of soil and water, which is the first requirement for soil improvement.

Wind Resistance of Asphalt Shingles

(Continued from page 552)

With the exception of the extra twenty per cent filler in the coating of the thick-butt shingles, performance comparisons of these two groups of shingles may be made with the assumption that any differences are due mainly to variation in design. Fig. 7 shows the initial bending resistance and the continued bending resistance through five bends for the two groups of shingles at the three different temperature levels tested. These curves represent average performances for all nailing patterns tested. It is noted that the initial bending resistance of the thick-butt shingle group was lower in all cases than the uniform thickness group and the resistance also dropped off faster with successive bends. The greatest difference between the performance of the two groups was at the lower temperature, where considerable tearing past the nails resulted with continued bending of the thick-butt shingles.

Fig. 8 shows the comparative bending resistances when the shingles were nailed with six nails at various distances from the butt edge. At the $4\frac{5}{8}$-in distance the thick-butt shingles performed the best because full advantage was taken of the added weight of the butt. When the shingles were nailed properly at $5\frac{5}{8}$ in high, very little difference was noted other than a slightly more rapid reduction in resistance with continued bending. The greatest weakness of the thick-butt shingles showed up when the nails were placed higher than specified as indicated from the $6\frac{1}{8}$ and $6\frac{5}{8}$ in spacing.

Fig. 9 shows comparative bending resistances for shingles nailed with four and six nails at the two-edge distances of $5\frac{5}{8}$ and $6\frac{5}{8}$ in. Very little advantage was indicated for the extra two nails with the uniform-thickness shingles. Also, if only the standard nail spacing of $5\frac{5}{8}$ in had been plotted, very little advantage would have been indicated for the thick butts. At the higher nail spacing, however, the extra two nails added considerably to the resistance of thick-butt shingles and for that reason are good assurance, as many nails in actual field application are placed much higher than specified.

CONCLUSIONS

1. There is a highly significant correlation between over-all weight of asphalt shingles and the initial bending resistance with a somewhat lower correlation with the resistance after five bends, which indicates that some factors other than mere weight affect the ability of asphalt shingles to sustain bending stresses.

2. Of the basic ingredients of asphalt shingles, the additional weight of felt has the most highly significant beneficial effect on bending resistance, while the addition of mineral either as filler or granules has a less significant harmful effect.

3. On a performance basis against wind stresses, uniform-thickness asphalt shingles make more efficient use of the materials from which they are manufactured than do the thick-butt types.

4. The advantage of bending resistance of uniform-thickness asphalt shingles over thick-butt types increases as the temperature drops from 85 to 55 F.

5. Six nails per strip shingle offer added bending resistance over four only when the nails are placed higher than specified. The greatest advantage is shown for the thick butts where the extra two nails help prevent the shingles from tearing past the nails.

6. Higher nailing than the specified $5\frac{5}{8}$ in for thick-butt shingles is very serious as it results in the nails being placed near, on, or above the weak transition lines.

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Comparison of Various Methods of Brooding

By J. Roberts, J. S. Carver, and W. E. Matson
MEMBER ASAE ASSOC. MEMBER ASAE

IN 1949 a comparative poultry brooding project was authorized at the State College of Washington. It is a cooperative project between the Washington Farm Electrification Committee, the department of poultry science, and the department of agricultural engineering. All tests were made in the brooding laboratory at the College. This paper comparing various methods of brooding thus far studied under this project is a progress report only since other tests are now under way.

The laboratory is a frame-type building (Fig. 1) with a corrugated aluminum roof and with exterior plywood both outside and inside. Fig. 2 shows it divided into eight rooms 8 x 10 x 8 ft, and two rooms 7 x 8 x 8 ft. One of the smaller rooms is used for the instruments and the other for storage of feed and equipment. Walls have 2 in of blanket-type insulation. The calculated over-all heat-transfer coefficient is 0.102 Btu per hr per sq ft per hr per deg. The ceiling is insulated with 5 in of wood shavings. The building is equipped with a heat exchanger and a forced ventilating system. Each room is equipped with a thermostat controlling a damper motor which regulates the supply of incoming air. The damper motor and the modulating valve are set to give two air changes per hour in a closed position and ten air changes per hour in the open position.

Test rooms are equipped for duplication of each brooding method so that with the eight rooms four methods of brooding may be studied at any one time. The building was originally equipped with two electric hovers, two rooms with electric underfloor radiant heat, two rooms with underfloor hot water radiant heat, and two rooms with a butane hover-type brooder. Conventional electric hovers were 42 in in diameter and were equipped with 1,000-w heating units. Underfloor electric radiant-heated rooms were equipped with two 1,500-w heating elements. Heating cables were placed under the entire floor and were wired so that half or all of the floor could be heated. This installation gave 3.75 w per sq ft for the heated area.

The two rooms equipped with the hot water systems were each heated with a 52-gal, 3,500-w electric water heater. Two systems of ¾-in pipe were installed under the floor of two rooms so that the entire floor area or half of it might be heated at once. The gas brooders were of the conventional hover type, 42-in diameter, and each had a 3,500 Btu-per-hr gas burner. The gas brooders were used for tests 1, 2, and 3.

For tests 4, 5, 6, and 7, the butane brooders were removed and heat lamps installed. The heat-lamp installation consisted of four 125-w heat lamps in each room. A "Variac" was used to control the voltage, thereby regulating the amount of heat from the lamps. Temperatures of all rooms were set to give chick comfort as determined by bird reactions. For chickens, 120 to 130 chicks were started in each pen. When brooding turkeys, 80 to 100 poults were started in each pen. All birds were taken directly from the College hatchery.

The following data were taken: Ventilation — the desired air changes were set at the start of each test, and checked once each week. Temperatures — chick height, room, outside, and air in and air out of the heat exchanger, were recorded by a potentiometer. The potentiometer was equipped with a cycle time clock so that temperatures were recorded once each hour. Room temperatures and room relative humidities were recorded by hygrothermograph. Mortality was recorded daily. Energy was measured by a watt-hour meter and recorded daily. Feed was weighed and recorded weekly. Bird weights were taken and recorded weekly. Energy distribution under the heat lamp was measured at the beginning of each test and checked weekly by a radiation meter.

RESULTS

The mean results are illustrated by Figs. 3 and 4, and further discussed below.

Mortality. Management was the greatest factor in mortality. Fig. 3 indicates that the hover-type brooder had the lowest mortality. However, if the data are analyzed statistically, there is no significant difference. In one test, the attendant left the window open and eight birds were lost one night. In this particular pen, fourteen birds were lost in total. In the companion pen, only two birds were lost.

In another test, four birds were lost one evening because the attendant left the feed can too close to the corner and the birds crowded into that area. Five birds were lost in this pen during the test, while only one bird was lost in its companion pen. The hover seems to offer more protection to the birds than the other methods used in this study.

Energy Costs. Bottled gas was used as a method of brooding in two pens for three tests, and the heat lamp was used for the same two rooms for four tests. Bottled gas in eastern Washington costs 10.7c per lb. Bulk LP gas in our area is approximately half this cost. Heat lamps were substituted for the rooms using bottled gas for two reasons: (1) the high cost of fuel and (2) the increasing demand for information on the use of the heat lamps for brooding.

In the first five tests, the entire floor areas were heated in the rooms using the underfloor electric heat and the underfloor hot water heat. We were primarily interested in the effect of heating — radiant, hover, and underfloor — on the growth and feed requirements of the birds. Consequently, the energy costs of the pens using underfloor electric and underfloor hot water, although interesting for comparison, are not valid because more heat was supplied than was required. The entire floor area was heated in these rooms for the first five tests. A considerable reduction in energy requirements was obtained by heating only one-half of the floor area for these pens in the last two tests.

If the brooder house is well constructed so that the floor temperature may be held low enough for the comfort of the birds, there can be an energy saving in heating only part of the floor area. In the case of poor brooder house construction, it may be necessary to heat the whole floor to maintain comfort for the birds.

The electric hover required the least amount of energy, followed by the heat lamp, the underfloor electric, the bottled gas, and the underfloor hot water. When only half the floor was heated with the underfloor electric system, then the energy consumption by this method and by the use of the heat lamps was essentially the same. The energy cost for the hot water method was extremely high. Because of this, that method was discontinued for the 1952 tests. Electric energy costs were

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1951, as a contribution of the Rural Electric Division.

The authors: J. ROBERTS, agricultural engineer; J. S. CARVER, poultryman; and W. E. MATSON, junior agricultural engineer (on military leave), Washington Agricultural Experiment Stations, Pullman.

Fig. 1. The poultry brooding laboratory at the State College of Washington used for the tests reported in the accompanying paper.

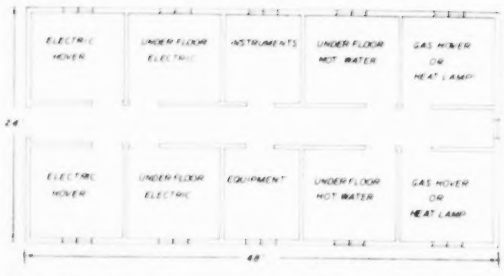

FIG. 2. Floor plans and floor cross section of the poultry brooder laboratory.

calculated at an electric rate of 1c per kw-hr.

Temperatures. Bird height temperatures were recorded by thermocouples and a potentiometer, using the black-ball method. Recordings were made once each hour for each of the eight pens. The data show that the temperatures at chick height were essentially the same for all brooding methods. The mean bird height temperatures were as follows: Electric hover, 85.8 F, underfloor electric, 84.2 F, underfloor hot water, 85.3 F, bottled gas, 85.7 F, and heat lamps, 84.4 F. It was observed, however, that the radiant-heat pens could be maintained at a little lower temperature than the hover type pens and still get a comfortable reaction from the birds.

Feed Consumption. The pounds of feed consumed per bird were nearly the same for all methods of brooding (Fig. 4). There is a slight discrepancy in comparing the bottled gas and the heat lamp methods with the other three methods. However, if the mean for the bottled gas and the heat lamps is taken, there is no significant difference in the feed consumption for the methods tested. The difference in feed consumption for the bottled gas and the heat lamps is attributed to the difference in the birds used for the tests, rather than the methods of brooding. Tests were made using White Leghorn, New Hampshire, and crossbred chicks; and two tests were conducted using Broad Breasted Bronze poults.

Bird Gain. There is no difference in gain in weight for the birds brooded by the electric hover, the underfloor electric, and the underfloor hot water methods (Fig. 4). There is some discrepancy for those brooded by the bottled gas and heat lamp methods. However, if these two are averaged, the figure will come out to be 1.00, or practically identical with the other three methods of brooding. Again the difference is attributed to birds used for the tests rather than the method of brooding.

Pounds of Feed per Pound of Gain. There is no significant difference in the pounds of feed per pound of gain for the birds brooded by the electric hover, the underfloor electric, and the underfloor hot water methods (Fig. 4). There again seems to be a discrepancy in comparing the feed efficiency of the birds brooded by the bottled gas and the heat lamps with the other three methods of brooding. However, if the bottled gas and the heat lamps are averaged, we get a figure of 2.23 lb of feed per pound of gain, which is practically identical with the results of the other three methods.

It is rather interesting to note that the efficiency of the birds in converting feed into meat was different for the various breeds. Turkeys were more efficient *(Continued on page 560)*

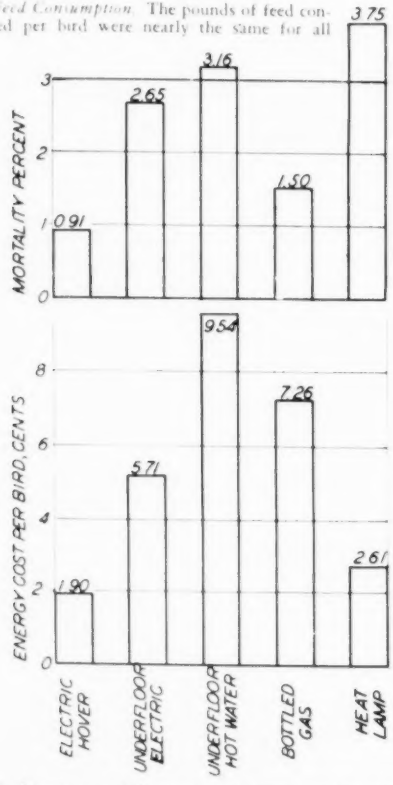

FIG. 3. A comparison of the mortality and energy costs for the methods of brooding used in the study. Mean of seven tests. Each test of five weeks' duration.

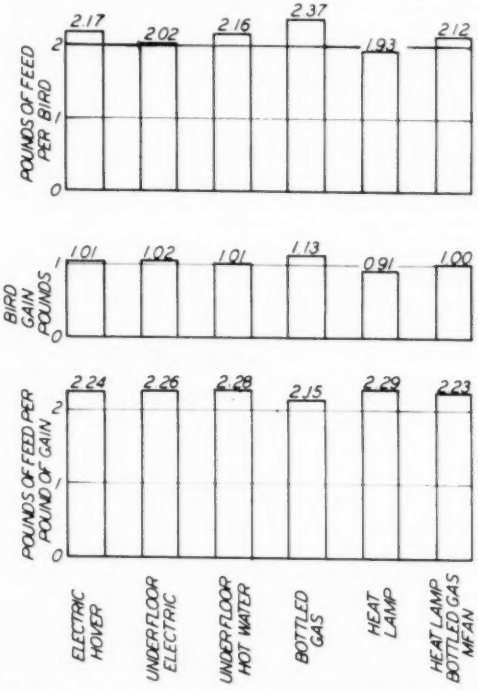

FIG. 4. A comparison of feed consumption, gain and feed efficiency for the methods of brooding used in the study. Mean of seven tests. Each test of five weeks' duration.

Effects of Irrigation Droplet Size on Infiltration and Aggregate Breakdown

By Gilbert Levine
AFFILIATE ASAE

ALTHOUGH many experiments have been carried on during the past few years to show the effect of raindrop impact on soil erosion, aggregate breakdown, and infiltration capacity (1, 2, 3)*, little has been done to make comparable studies regarding sprinkler irrigation. Since it is not possible to change the size of the raindrops, reduction in the effect of raindrop impact must, therefore, be accomplished by better cover conditions, improvement in surface soil structure, and by improved cultural methods. However, with sprinkler irrigation there is the opportunity to change the size of the drops being applied. Nevertheless, there are limits to the drop-size reduction. Economic considerations resulting from the increased pressures which are necessarily involved and the effect of changing drop size upon distribution patterns are only some of the factors involved. Since sprinkler-irrigated crops are often clean-tilled, the use of mulches is curtailed and other methods designed to reduce impact effect may be restricted. Thus, even considering the possible limitations imposed upon sprinkler drop-size reduction, the problem is one of sufficient importance to warrant investigation.

The following is a description of some experiments that have been carried out to determine the effect of sprinkler irrigation on aggregate breakdown and infiltration capacity. As a prerequisite, it was necessary to obtain information relative to the drop sizes produced by sprinklers operating under varying conditions of nozzle size and pressure. Included herein are complete results of the drop size — nozzle size — pressure and infiltration capacity experiments, as well as preliminary results of the aggregate breakdown study.

DROP SIZE

Method. The measurements of drop size were made on a series of five so-called "range nozzles" (those which emit a stream of water toward the outer rim of the pattern) 10/64 in through 14/64 in, and under a range of pressures of 20 through 60 psi. The pressures were measured as velocity heads with a Pitot tube placed 1/8 in from the nozzle orifice, to eliminate any variation in the fittings used. Drop-size measurements were made at 5-ft intervals along the radius of the pattern.

The actual method of obtaining the drop size is a modification of a method used by Weisner in 1895 (4) to measure raindrops. In this case, paper towelling was used as the indicating paper. The paper was clipped to a board which was then held horizontally at the specified distance from the nozzle. The paper was passed through the stream of drops and then photographed. Upon completion of the tests, the films were projected on a screen to twice the original size and measured.

Results. The results are in terms of apparent drop diameter, which is the measured diameter on the indicator paper. The apparent diameter is a function of the actual drop diameter, the angle of impact, the velocity of the drop and the type of indicator paper. Therefore, no simple relation between apparent diameter and actual drop diameter exists. This limits the applicability of the results, but they are still useful in comparing the effects of the various operating conditions.

Fig. 1 shows typical profile patterns of a rotary sprinkler, as determined by the method described. From the sprinkler to a distance of 25 to 30 ft, the diameter of the drops is relatively small, increasing with distance. The lines shown in Fig. 1 are mathematically fitted to the data and do not show the variability of the data. It may be said that the drop diameters decrease with increasing pressure and, to some extent, with decreasing nozzle diameter. In this region (0 to 30 ft) the effect of the hammer interrupting the stream has more of an effect on the drop size than does the nozzle size.

From 30 to 50 ft, the drops are the result of the main, uninterrupted jet of water, and here the drops increase in diameter much more rapidly.

The effect of changing the nozzle size and pressure is illustrated in Fig. 2. The results are as might be expected, drop diameter decreasing with decreasing nozzle size for a given operating pressure, and decreasing with increasing operating pressure for a given nozzle size.

The above results provide a basis for comparing the various operating conditions, in terms of the apparent drop diameter produced.

INFILTRATION CAPACITY

Method. Three ranges of drop size were selected for the infiltration capacity study: 0-5, 5-15, and 15-25 mm diameter (as shown on the indicator paper). Six materials were irrigated:

1. Uniform coarse sand (½ to 1 mm)
2. Uniform fine sand (28 to 40 mesh)

Paper presented at a conference on sprinkler irrigation sponsored by the ASAE Subcommittee on Sprinkler Irrigation Research and held during the winter meeting of the American Society of Agricultural Engineers at Chicago, December, 1951.

The author: GILBERT LEVINE, graduate assistant in agricultural engineering, Cornell University, Ithaca, N. Y.

*Numbers in parentheses refer to the appended references.

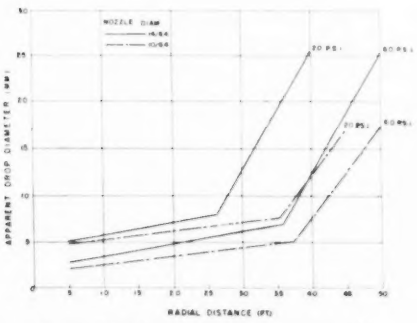

Fig. 1 Typical profile patterns of a rotary sprinkler

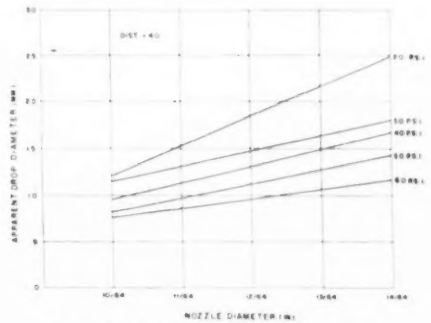

Fig. 2 Effect of changing the nozzle size and pressure

5. Graded sand
4. Dunkirk silty clay loam (slowly permeable)
5. Merrimac sand
6. Marsden silt loam (moderate to moderately slowly permeable).

Two trays (4 in deep) of each material were required for each range of drop sizes per replication; there were four replications of the experiment. The trays were prepared as nearly alike as possible, all materials being in a moist condition and compacted with a flat board. After compaction, they were placed on a rack and a water table was established 2 in below the surface of the material. After 24 hr, one of each pair of trays was allowed to drain. These six trays were then irrigated at a rate of approximately $1\frac{1}{2}$ iph for a period of 1 hr.

Shortly before the irrigation was completed, the other six trays were allowed to drain. The infiltration capacity of the twelve trays was then measured by applying $\frac{1}{2}$ in of water to the surface and recording the time for disappearance. The value for the unirrigated tray of each pair was considered as the "initial infiltration capacity" and the value for the other the "final infiltration capacity."

Results. The effect of the impact of various size drops on infiltration is shown in Fig. 3. The per cent decrease in infiltration capacity is the decrease in infiltration divided by the initial infiltration capacity.

Increasing the drop size resulted in a statistically significant decrease in infiltration capacity for the soils. The values obtained for the soils were significantly different from one another, but those obtained for the sands were not. The sand decreased in infiltration capacity with the larger drops, but not as rapidly.

It may be concluded that the decrease in infiltration capacity that resulted was due in part to a physical compaction of the material, and in part to a sealing of the surface layer. Further information on this will be forthcoming when the volume weight and penetrometer data are available.

AGGREGATE BREAKDOWN

Method. Preliminary experiments were carried on to determine the comparative magnitude of aggregate breakdown of the various drop sizes. High organic matter soil was sieved through a $\frac{1}{4}$-in screen, allowed to air dry, and then sieved for the 2 to 5 mm size fraction.

One hundred grams of these aggregates were placed on a 6-in square screen (2 mm openings) forming a layer of from $\frac{1}{8}$ to $\frac{1}{4}$ inch depth. The screen was placed on a waterproof box and the complete unit irrigated. The drop size and rate of application were varied. The material passing through the screen into the box, upon irrigation was weighed.

Determinations relating to aggregate breakdown have been made in the infiltration capacity experiment. These include volume weight determinations of the surface crusts and subsurface material, in addition to penetrometer studies of the crusts. These results are not available at the present time, but will be completed in the near future.

Results. The results of the aggregate breakdown study are shown in Table 1. It is readily apparent that increasing the size of drops markedly increases the aggregate breakdown. The values shown for the 15 to 25-mm range do not give a true picture of the actual effect. When the samples were irrigated with the large drops, much of the aggregate sample was splashed off the screen — often as much as 50 per cent. Thus the values given in the table are much lower than would have resulted if there had been no splash effect.

TABLE 1. PER CENT MATERIAL PASSING THROUGH SCREEN

Apparent drop dia., mm	Intensity, iph 0.4-0.6	0.6-0.8	0.8-1.0	1.0-1.2	1.2-1.4	1.4-1.6	1.6-1.8
0-5	6.5	5.3	4.5	5.8	5.0	5.3	5.2
5-15	22.0	20.1	18.0	23.5	26.5	26.0	27.2
15-25	30.0	28.4	38.0	54.0	57.4	52.2	50.3

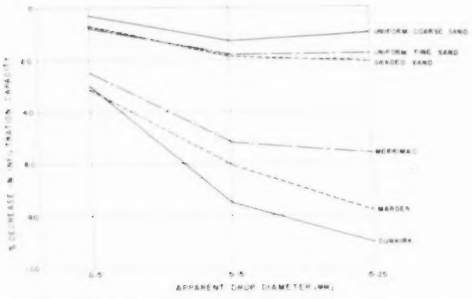

Fig. 3. Effect of impact of various size drops on infiltration.

The rate of water application had no significant effect on the amount of material passing through the screen when the drop size was held constant.

CONCLUSIONS

On the basis of these results, it becomes apparent that the effect of the size of irrigation drops on soil structure may be an important factor to consider when designing an irrigation system. However, this is not conclusively proven. Since a sprinkler produces a wide range of drop sizes, the over-all integrated effect must be evaluated under field conditions. In the field, it is entirely possible that this integrated effect may serve largely to eliminate the differences.

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Comparison of Brooding Methods

(Continued from page 558)

than the crossbred, the New Hampshire, or the White Leghorn chickens. The crossbred chickens, however, were more efficient than the White Leghorns or the New Hampshires.

CONCLUSIONS

From the results of these tests and from observation, there is no significant difference in the methods of brooding on the gain, feed consumption, or feed efficiency of chicks or poults. As a general conclusion, the hover-type electric brooder has lower energy consumption than the other methods studied. While the data show insignificant differences, it also appears that the hover-type electric brooder is conducive to lower mortality, partially because the birds can "protect themselves" from some mismanagement factors.

There is probably an advantage in radiant heating over the hover method in that the poultryman can always see the birds. However, the value of this advantage in dollars and cents is unknown. There is certainly an advantage by using the underfloor heat method or the heat lamps, in that dry litter is always maintained. The monetary value of dry litter is yet to be determined.

Initial investment in using heat lamps was much less than for the other methods. However, the energy cost for this method is more than for the hover method of brooding. For the "backyard poultryman", the initial investment may be of more importance than the energy consumption, since the energy cost in either the hover method or the heat-lamp method is quite low.

Mechanization of Peanut Production in Texas

By J. W. Sorenson
MEMBER ASAE

THE peanut is an important cash crop to Texas farmers. The average annual acreage for the 10-year period 1939-48 was 645,000 acres, with an average annual production of 283,952,000 lb. Texas farmers received about $34,300,000 for the peanuts they grew in 1950.

Prior to 1941, Texas peanut growers relied entirely on horses and mules for power. During the past ten years, however, tractors have practically displaced animals as a source of power. Until the last few years, nuts were usually removed from the vines by using a stationary thresher. Now the combine-thresher is rapidly replacing the stationary machine. It is estimated that 75 per cent of the 1951 crop was harvested by combines.

PLANTING AND CULTIVATING

Tractor power is used almost altogether for planting and cultivating operations. In the fairly level and prairie areas most of the growers use four-row equipment. In the rolling and hilly sections of the state two-row equipment is used with good success. A 40-in-row spacing is generally used.

Standard cotton and corn planters equipped with plates for planting peanuts are used by many of the growers. Others use a slant-bottom hopper or a special planting attachment designed to plant shelled peanuts.

HARVESTING AND THRESHING

Raking. The use of a side-delivery rake was the first step in the reduction in harvesting labor. It eliminated shaking by hand and greatly reduced the labor of piling which was required when peanuts were threshed with a stationary thresher. In the early use of tractors, digging and raking were separate operations. Later, some growers found it practical to dig and rake in one operation to further reduce the labor and equipment required. More recently commercial shaker-windrow attachments have been developed that are taking the place of the side-delivery rake.

Converted Grain Combines. To the ingenuity of the Texas farmer must go much of the credit for the development of the peanut combine. As early as 1941, farmers successfully rebuilt grain combines into peanut combines.

In 1945 the International Harvester Company placed an experimental combine with the Texas Agricultural Experiment Station at Stephenville to be used for threshing peanuts direct from windrows. Based on the performance of this machine in the first threshing trials during the 1945 harvest season, the following major structural changes were made before it was used in the 1946 season:

1 A spring-tooth cylinder was installed to replace the spike-tooth cylinder. Adjustable spring teeth were placed in the concave and inserted from underneath through the openings formerly occupied by the spike teeth.

2 The beater was replaced with another spring-tooth cylinder, and the finger grates were left in place to serve as a concave. Adjustable spring teeth were passed up through the finger grate concave.

3 Screens similar to those used in stationary threshers were installed.

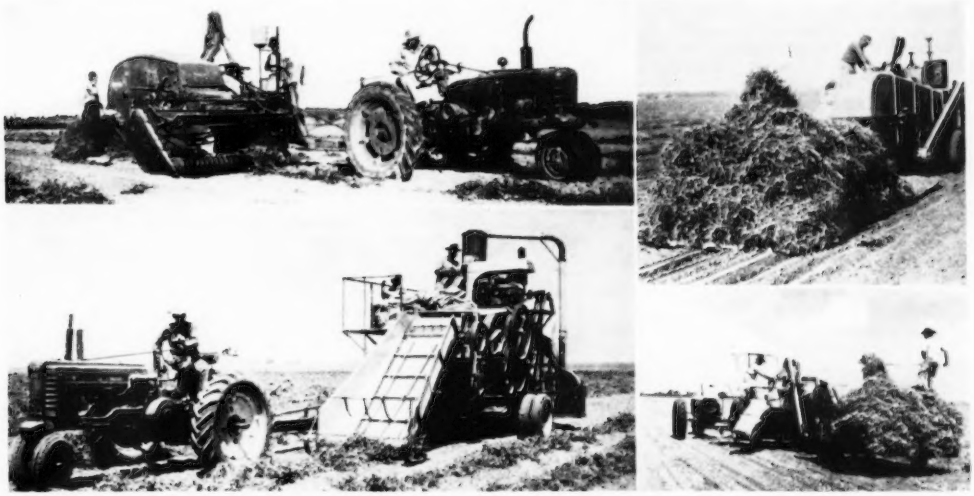
4 The speed of the cylinders was reduced to approximately 420 rpm.

5 A hydraulic lift was connected to the pickup attachment to facilitate the almost constant raising and lowering that is necessary where the land is uneven.

With these modifications, this combine proved successful for harvesting peanuts from the standpoint of doing an excel-

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Kansas City, Mo., June, 1952, as a contribution of the Power and Machinery Division.

The author: J. W. SORENSON, associate professor of agricultural engineering, Texas Agricultural Experiment Station.



(Upper left) An experimental combine used to thresh peanuts at the Texas Agricultural Experiment Station at Stephenville. Note the slide for catching the hay. • *(Lower left)* A stationary thresher that was converted into a mobile peanut thresher by A. W. Schilds, of Waller, Tex. With this machine three to four men do the same work ordinarily required of 12 to 15 men with a stationary thresher. The machine picks up the vines from the windrow and delivers the threshed nuts to a sacking spout. The vines are carried to a feed mill mounted on the thresher. The finely cut hay is then blown into a feed collector where the material is sacked. • *(Upper right)* A simple method for saving peanut hay when threshing is catching it on a slide pulled behind the combine. The hay is dumped at suitable intervals for convenient baling. • *(Lower right)* Some growers pull a two-wheel, homemade self-dumping wagon behind the combine to catch the hay.

lent job of threshing as well as obtaining high commercial grades. It was found, however, that the original engine that was used to operate the threshing unit did not have sufficient power for peak loads caused by heavy bunches of peanut vines. This slowed down travel along the windrow to some extent.

Converted Stationary Threshers. It was not easy to get grain combines to convert during the war years. It was then that farmers turned to making the best possible use of the equipment they owned.

At first, a regular thresher, equipped with an auxiliary engine, was pulled down the windrow and the peanuts were pitched into the machine as it was pulled very slowly. It was not long, however, until growers were converting their threshers into a combine. This was accomplished by mounting the thresher on a single axle with dual wheels, installing a pickup feeder and auxiliary engine and adding a sacker and a sacker platform high enough for the men to be above the dust of the thresher. This equipment worked so effectively that it was not long before these machines were widely used. At the present time, converted threshers are being used in most all of the peanut producing areas of the state. These machines are too heavy for deep sand and hilly areas in some sections, however.

One of the most recent developments in peanut harvesting equipment is a machine developed by A. W. Schilds of Waller. Mr. Schilds converted a thresher in the usual way, but in addition enlarged the sacking platform and mounted a hammer mill at the rear of the combine. With this machine the peanuts are dug in the usual manner and allowed to cure in the windrow for two or three days. If weather conditions are favorable, the vines will be dry enough to store without spoilage after this length of time. The harvesting machine picks up the vines from the windrow and delivers the threshed peanuts to a sacking spout on the platform. A cross conveyor catches the vines at the rear of the combine and carries them to the feed mill. The finely cut hay is then blown into a feed collector on the sacking platform where the material is sacked.

There are still quite a few local machine shops that do a good business in converting stationary threshers and grain combines into mobile peanut threshers. Commercial machines are now being tested and placed on the market, and these likely will eventually replace the shop-converted machines.

Disposal of Hay. The most convenient method to dispose of peanut hay in combine threshing is to permit it to fall to the ground and then plow it under to supply organic matter for the soil. Many growers, however, prefer to save the hay for livestock feed and to provide organic matter by the use of cover crops.

A simple method by which hay may be saved when threshing with a combine is by catching it on a slide or drag pulled behind the combine. By attaching a strip of heavy-mesh fencing wire to one end of the slide and laying this the full length and width of the slide, the hay may be easily dumped at suitable intervals for convenient baling. Some growers pull a two-wheel homemade self-dumping wagon behind the combine to catch the hay. Others catch the hay in a wire basket attached to the combine. These baskets hold about three bales and are self-dumped by the tractor driver when full.

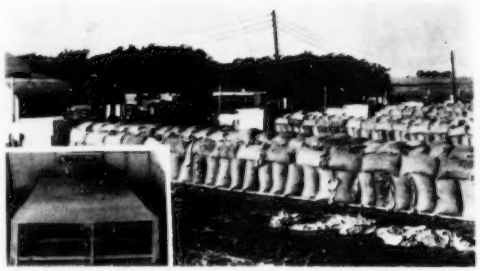
DRYING THE THRESHED NUTS

Before peanuts are sold, they should be dried until the moisture content is not more than 7 to 8 per cent.

Field or Shed Drying. The most common practice is to let the peanuts dry in the windrow from three to ten days, depending upon the weather. Then, after threshing, the drying is completed by stacking the bags in the field, or in an open shed where air can circulate freely.

Artificial Drying. Almost every year, in certain peanut-producing areas there are frequent heavy rains during the harvest period. Even in the drier regions wet seasons occur occasionally. Under these conditions, natural drying in the field, or under a shed, is extremely difficult. As a result, there has been an increasing interest in artificial drying within the past few years.

During the past six years, agricultural engineers at the Texas Agricultural Experiment Station have successfully dried peanuts with heated air.



Drying peanuts in sacks on the A. W. Schilds' farm near Waller, Tex. The insert shows the tunnel around which the peanuts are stacked.

Peanuts have also been artificially dried successfully by a few farmers and custom driers. The nuts have been dried both in sacks and bulk. Both stationary and portable-type driers are in use.

In artificial drying, the usual procedure is to let the nuts stay in the windrow for at least two days before they are threshed. Immediately after threshing they are carried to the drier where the excess moisture is removed by circulating heated air through the nuts. The temperature of the drying air should not exceed 125 F. The drying time will usually vary from 2 to 8 hr, depending on the initial moisture content of the nuts.

The drying operation should be stopped when the nuts have reached a moisture content of about 10 per cent. Tests have shown that the nuts will lose an additional 2 to 3 per cent moisture during the first 24 to 48 hr after drying. This moisture is absorbed by the dry hulls.

One of the most important factors in the successful operation of a drier is to avoid overdrying. Nuts that are too dry crack badly during shelling.

A number of growers and research workers have given considerable thought to the possibility of artificially drying green peanuts which are combined or threshed immediately after digging. There has been very little research on this method of harvesting and drying in Texas. In some of the tests, however, the dry nuts had a disagreeable flavor. Further experiments will be necessary to determine the feasibility of this method of drying peanuts.

SUMMARY

Tractors have practically displaced animals as a source of power in peanut production in Texas. The combine thresher is rapidly replacing the stationary machine. It is estimated that 75 per cent of the 1951 crop was harvested by combines.

As early as 1941, Texas farmers successfully rebuilt grain combines into peanut combines. Tests made by the Texas Agricultural Experiment Station show that these combines do an excellent job of threshing as well as obtaining high commercial grades. Many growers have successfully converted stationary threshers into peanut combines.

Peanuts have been successfully dried with heated air. The nuts have been dried both in sacks and in bulk.

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A Photographic Technique for Measuring the Sizes and Velocities of Water Drops from Irrigation Sprinklers

By Robert L. Green
MEMBER ASAE

PHYSICISTS and meteorologists have been interested in the phenomena of the distribution of drop sizes and the velocities of raindrops for the past 75 years. In the past 15 years the interest of engineers and other agricultural scientists has been focused to some degree on these phenomena in their efforts to determine the mechanics of soil erosion and to develop techniques and/or practices to prevent erosion and its allied results of surface sealing, decreased aeration and infiltration capacities, and other damage to the soil structure detrimental to crop production.

The natural evolution now is the expansion of this interest in rain-drop information to the field of sprinkler irrigation where the characteristics of a sprinkler determine the drop pattern, and where corrective measures to offset the detrimental effects of drop impact on the soil may be applied before the water emerges from the sprinkler orifice or orifices, as well as to the soil. A major problem in the design of sprinkler irrigation systems is the development of practical procedures for determining the effects of sprinkler irrigation on the soil.

These effects may be determined: first, the distribution of drop sizes and drop velocities of sprinklers throughout their range of operating pressures, and, second, a measurement of the effect of the drop patterns thus described on "standard" soil conditions, thereby permitting local adaptations for more adequate design.

The present methods of design can then be modified to more nearly approach the optimum compromise between operating pressures, spacings, effects on the soil, and the evaporation losses. The fact that these factors oppose each other makes it even more important that as much information as possible be accumulated on all of them. An illustration of the point may be taken from a recent quotation of a Tennessee agricultural engineer to the effect that livestock on an overgrazed pasture were found to be consuming 700 lb of soil per oven-dry ton of forage following an intense rainstorm that ended suddenly. In this particular case fluorine had been applied in the fertilizer and the livestock were poisoned. This further suggests that, when irrigation applications are made on food and forage crops, the pressure should be increased for a few minutes before the system is shut off to obtain the rinsing action of the fine drops of water that would be distributed.

The work reported here has for its objective the development of techniques of adequately measuring the characteristics of irrigation sprinklers and the effects of various drop-size and velocity patterns on "standard" soils. This information could be added to the present information furnished by manufacturers on discharge and radius of coverage. The results obtained to date barely introduce the subject but may serve to present an approach to the problem and to furnish a background for additional investigations in the future.

Mechanics of Dispersion of a Stream of Water. The mean velocity of a water jet emerging from an orifice may be readily determined by measuring the discharge for a period of time, but it is well established in hydraulic studies that the actual velocities vary from near zero at the perimeter to a maximum at the center of the stream. Immediately after passing the vena contracta this variation in velocities in the stream and the rotation of a sprinkler cause the initial breakup of the stream into various sized drops and droplets. Further breakup of drops beyond the effect of the emergent turbulence and the mechanical dispersion of the rotating sprinkler becomes a function of surface tension of the water and the resistance of the air to the passage of the drops. The surface tension tends to hold the drops intact in a sphere, while the air resistance tends to cause oblation by flattening the leading side of the drops. When the oblation is to such a degree that the air resistance exceeds the surface tension, the drops break up into two or more drops and several small droplets. Blanchard (1)* has shown drops larger than 5.4 mm equivalent spherical diameter to be unstable, i.e., they will break up if they fall far enough. Blanchard also found that drops smaller than 4.6 mm in diameter were stable and would remain intact even though a continuous oscillation occurred in both the major and minor axes. Intermediate sized drops between 4.6 and 5.4 mm sometimes separated and sometimes remained intact. There may be a logical doubt as to the validity of these points of stability for water from irrigation sprinklers. This question should be raised because Blanchard was dealing with drops of water falling in a wind tunnel subject only to the force of gravity where there was a gradual acceleration to the terminal velocity, whereas in a stream emerging from a sprinkler orifice the initial mean velocity is far above the terminal velocity.

The actual points of stability appear to be unimportant since many large drops will strike the ground before travelling far enough either to break up or to slow down to terminal velocity. The important consideration is that the shape of the drops is dynamic and that breakup is a continuing process through the trajectory of the stream. Additional breakup, and to a minor degree buildup, of drop size probably occurs due to the collision of drops. Collisions will commonly occur by fast-moving drops overtaking slower drops. This phenomenon is apparent when one considers the kinetic energy of the drops and the air resistance acting upon them. The kinetic energy is directly proportional to the drop size and thus the third power of the radius and the air resistance (2) is proportional to the cross sectional area and thus the second power of the radius. Analysis of experimental data shows the latter relation to be $k = 0.00122d^{2.44}$. From this, the conclusion is drawn that the smaller drops decelerate more rapidly than larger ones and thereby may be overtaken by larger drops.

Mathematical Analysis of Distance of Travel and Velocity. Even though the mean velocities of streams emerging from sprinkler orifices for many sprinklers exceed 100 fps and the maximum velocities in the center of the stream are even higher, they are still within the range that the physicist considers the air resistance to be a function of the first power of the velocity. The equation for Newton's second law of motion may then be written and solved as below with the origin considered as the orifice. At time $t = 0$, r, the position vector, $= 0$, and velocity $= V_o$.

$$F = -mg - kv \quad [1]$$

where F = force, m = mass, and k = constant.

$$F = m(dv/dt)$$

$$dv/dt + (k/m)V = -g$$

$$Ve^{(k/m)t} = -g\int e^{(k/m)t}\,dt = -g(m/k)e^{(k/m)t} + C_1$$

$$V = -g(m/k) + C_1 e^{-(k/m)t} \quad [2]$$

At $t = 0$, $V = V_o$

$$V_o = -g(m/k) + C_1 \qquad C_1 = V_o + g(m/k)$$

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The author: ROBERT L. GREEN, assistant professor of agricultural engineering on leave from Louisiana State University, Baton Rouge, La., currently serving as agricultural engineer with a TCA mission to Indonesia.

*Numbers in parentheses refer to the appended references.

From equation [2] $V = V_0 e^{(k/m)t} + g(m/k)e^{(k/m)t} - g(m/k)$ [3]

Since $V = dx/dt$

$$x = \int \{V_0 e^{(k/m)t} - g(m/k)e^{(k/m)t} - g(m/k)\}dt$$

$$V_0(m/k)e^{(k/m)t} - g(m/k)^2 e^{(k/m)t} - g(m/k)t + C_2$$

Since at $t = 0$, $x = 0$, $C_2 = V_0(m/k) + g(m/k)^2$

$$x = V_0(m/k)[1 - e^{(k/m)t}] - g(m/k)^2 te^{(k/m)t} - 1] - g(m/k)t \quad [4]$$

Upon examination of equation 4 it is apparent that, if the limit of the value m/k is zero as the size of a drop decreases, very small drops will travel negligible distances. That the value of m/k does approach zero as its limit is indicated in a previous evaluation of k (5), since the ratio of m/k decreases from 0.90 for a drop of 5.92 mm diameter to 0.47 for a drop 1.47 mm in diameter.

These solutions have no direct application with the data collected to date but are presented to show the fundamental relationship between drop size and distance traversed. Since the distance of travel is proportional to the size of the drop, the distribution pattern of an irrigation sprinkler must depend upon the dispersion and the breakup of the discharged stream of water. It is also worthy of note that, if chemicals are distributed through solution in irrigation sprinklers, they will affect the distribution pattern if the surface tension of the water is materially affected.

Development of Photographic Technique. The first approach used in this study was modified from the technique of Laws (4) in that the field in front of the camera was sidelighted using a carbon-arc stage spotlight on either side of the camera with a black background behind the spray of water coming from a stationary sprinkler which was located so that the stream was perpendicular to the camera axis. This method did not prove satisfactory due to insufficient light when the shutter was rotated fast enough to obtain traceable drop paths. The shutter used was a plywood disk 28 in. in diameter with a hole cut between radii and concentric circles 12 in. and 13 in. in radius. The disk was mounted on a synchronous electric motor operating at 1800 rpm and so placed that the hole passed directly in front of the camera lens at a distance of one inch. The exposure thus obtained was 1/500 sec. The camera, lights, and mechanical shutter were protected from the water by sheets of plywood placed vertically between them and the sprinkler with a 2-in. interval between the plywood sheets through which the water passed into the photographic field.

Traces of drop paths were obtained on the photographic negatives and further refinements of the method may have given a satisfactory measurement of drop velocities. It was realized, however, that this technique would not give images of the drops but would show only the drop axis perpendicular to its path. Since the drops were not circular, this technique would not give an accurate measurement of the drop sizes. This conclusion is of marked importance in view of the oscillations of the drops; however, this is not a contradiction of the accuracy of Laws' work since he was dealing with drops of known size falling from capillary tubes.

Efforts were next directed toward photographs of the drops with the images of sufficient clarity to permit the measurement of the drop sizes just above the ground level. Pictures made with the carbon arc spotlights and exposures of 1/500 sec were weak in contrast and were blurred because of the motion of the drops which were passing only 42 in. in front of the camera lens. Trial pictures were then taken using a Heiland Strobonar I, electrically discharged flash lamp synchronized with the camera. This unit had a rated exposure of 1/1,000 sec, and when pictures seemed to have had insufficient light for sharp contrast with the background, the spotlights were used in addition to the "strobe" light. The results thus obtained were in effect double exposure caused by the two sources of light and gave not only the drop images as pictured by the intense short duration "strobe" light, but also the paths of the drops due to the exposure from the spotlights with the camera shutter set on 1/50 sec. Further efforts were then directed at improvement of this procedure which would permit the measurement of the drop sizes from the images and the velocities by measuring the length of path made during the time the camera shutter was open.

In his studies of drop oscillation, Blanchard reported that the addition of sodium chloride and silver nitrate to water in the proportion of one part per hundred thousand improved the quality of photographs. This addition results in a colloidal suspension of silver nitrate and the colloidal particles serve as minute reflectors that reduce the tendency for drop pictures to show only the sides of the drops. When sodium chloride and silver nitrate were added to the water in the above proportions, it was found that the desired pictures could be made outdoors using daylight as the source of continuous light and the Strobolume unit, manufactured by General Radio Corp., as the intense short-duration light (1/100,000 sec). This light has a photographic guide number rating of 50 as a single-flash unit and can be used as a true stroboscopic light when triggered by the Strobotac unit.

Several attempts were made to obtain multi-exposure pictures using the two units so that the velocity could be measured as the distance between images resulting from the repeated flashing of the light. These pictures could not be interpreted, however, because the limit of flashing rate (20 per sec) permitted the drops to travel distances of 1½ ft or more; with several drops in a picture the successive images of the same drops could not be selected. This method would be more desirable due to the accuracy of the flashing interval but would require a unit capable of at least 100 flashes per second and 200 flashes per second would be even better. Such a unit would eliminate errors due to variations in the actual time that a camera shutter is open, which is the major source of error in the results below.

Photographs of Drops and Drop Paths. In Fig. 1 the drops were moving directly toward the camera which was so placed on a high tripod that the spray of water was passing just under the camera bed and through the tripod legs. The camera was focused for a distance of four feet and at this distance the drop paths were practically in a direct line with the main axis of the camera. Study of this and another similar picture with the use of a reading glass shows the shape of the drops in a plane to be almost perfect circles. *(Continued on page 566)*

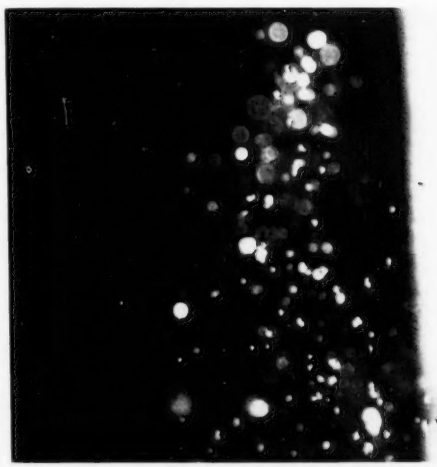

Fig. 1. Drops moving directly toward camera. Exposure, 1/1,000 sec. Light source, Strobonar I.

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There are many drops in the picture that are not in the field of focus and these are seen as fuzzy or transparent drops and were not considered. A few of the drops that definitely are not circular were the result of splash from the cover over the arc lights and were crossing the field at various angles. The plywood sheets in the background, while normally spaced less than two inches apart, were approximately three feet apart for this picture so that the full stream from the sprinkler could enter the photographic field. The sprinkler was stationary and approximately 50 ft from the camera.

In the trial-and-error method that was necessary to develop the photographic technique, it was considered necessary to restrict the depth of field of the water to about two inches to limit the error that would otherwise occur if the drops pictured were distributed over a wide range of distances from the camera. It was found to be necessary to eliminate any splash from the photographic field. These requirements were met by attaching 26-gage galvanized iron to the edges of the plywood sheets. Strips of this sheet metal were fastened to the front and back of the plywood and bent out at an angle of approximately 45 deg with the front edge extending $\frac{1}{4}$ in farther than the metal on the back side. With two sheets of plywood prepared in this manner and spaced so that a vertical slit 1 to 2 in in width was made, virtually no splash from the edges of the plywood entered the photographic field. It seemed that the drops that were split by the sharp metal edges were deflected into the space between the front and back pieces of metal attached to the plywood on the opposite side of the opening and were thus eliminated from the field.

It was found that the most satisfactory background behind the drops to be photographed was a piece of plywood painted with blackboard black paint. This gave a dull black field which reflected no light making the double exposure technique possible, as the only light reflected to the photographic negative was from the drops of water.

After the restricting boards and background board were in place, a meter scale and usually a printed card were placed in front of the camera and on a line from the sprinkler through the opening between the boards. The meter scale was then photographed using the exposure indicated by a Weston II exposure meter. This picture served both as a check on the accurate focusing of the camera and also as a scale for measuring drop sizes and lengths of paths for the drop measurements. The meter scale was then removed from the field and the sprinkler turned on, and since these were in the nature of preliminary investigations, the pressure was adjusted so that a reasonable amount of water was passing through the vertical opening between the restricting boards. Sodium chloride and silver nitrate crystals, one part per 100,000 had been added to the water for reasons previously described.

The sprinkler used was the Skinner Jr. Utility with a 7/32-in nozzle. The operating pressure of 25 psi was below the recommended pressure for this sprinkler, but it met the other desired requirements necessary for this group of pictures. The sprinkler was not allowed to rotate. It is believed that this variation from normal operation would not change the sprinkler characteristics, since no statistically significant difference was found between the discharge of a rotating sprinkler compared with the discharge while not rotating. Operating below recommended pressures would give a distribution of larger drop sizes.

Fig. 2 shows the drop images and paths obtained under the conditions described above. The light sources were daylight and the Strobolume light used as a single flash light synchronized with the camera shutter. The daylight was of sufficient intensity that the exposure meter reading at the camera lens was 50.

The camera was 4 ft from the restricting boards, 44 in from the line of focus and 32 in above the ground. The Strobolume was 1 ft farther from the sprinkler than the camera, but the same distance from the path of water and on a 36-in tripod. The sprinkler was 34 ft from the axis of the camera. The drop images may have been slightly clearer had the Strobolume been moved back a short distance. The exposures that gave the best results were obtained with the shutter set for a normal daylight picture.

The short path of the drops before the images results from the opening of the camera shutter before the trigger mechanism discharged the Strobolume light. The longer paths after the images are the streaks of light reflected from daylight while the shutter was still open.

The photographs of the drop and of the meter scale were enlarged to the same degree for the analysis. The lengths of drop paths were measured by placing the tips of dividers at the center of the image and the end of the path and then placing the dividers on the meter scale. The cross sectional areas of the drop images were measured by tracing their perimeters ten times with a planimeter. The planimeter constant was obtained as the average of ten calibration trials with the measuring wheel rolling on one of the photographs.

The time lengths of the drop paths were determined by checking the camera shutter with the Synchro-Check instrument made by the Heiland Co. This *(Continued on page 568)*

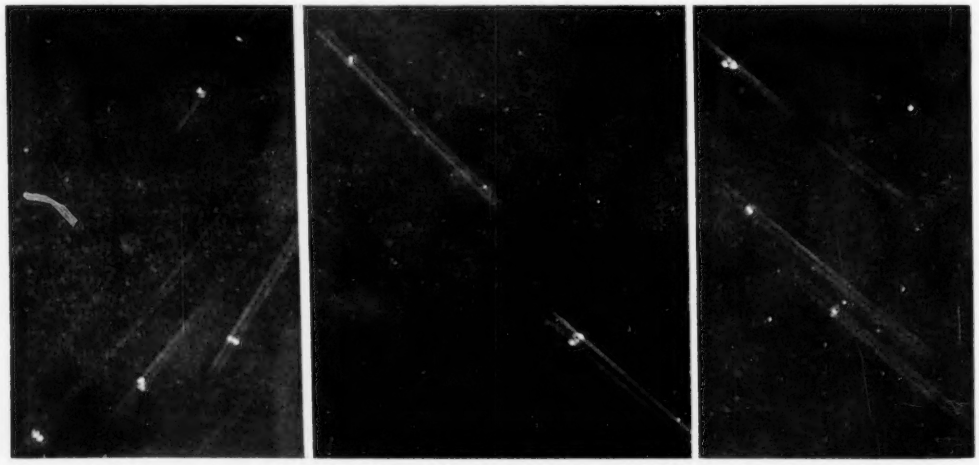

Fig. 2 Drop images and paths of motion. *(Left)* f 5.6 at 1/200 sec; *(Center)* f 5.6 at 1/200 sec; *(Right)* f 8 at 1/100 sec

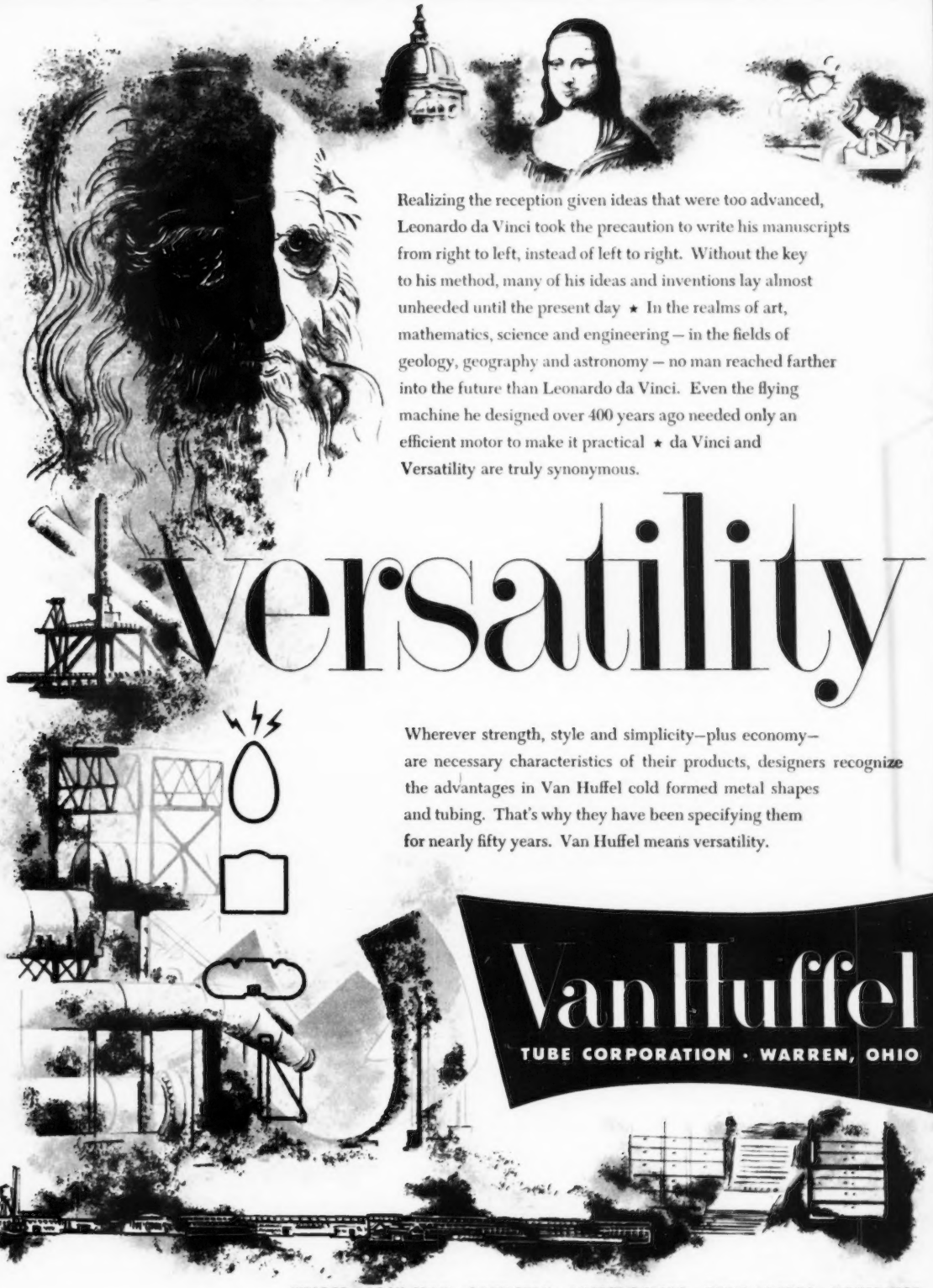

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TABLE 1. DROP AND VELOCITY MEASUREMENTS

Time length of path	Drop No.	Planimeter reading, 10 x area	Sectional area, cm²	Equivalent diameter, mm	Length of path, cm	Velocity, m per sec	Transverse axis, mm
Fig. 2 (Left) 0.010 sec	1	0.60	0.372	6.9	10.2	10.20	5.8
	2	0.60	0.372	6.9	10.1	10.10	7.0
	3	0.50	0.310	6.5	9.80	9.80	5.0
	4	0.70	0.434	7.4	9.90	9.90	4.5
Fig. 2 (Center) 0.010 sec	1	0.10	0.062	2.8	6.90	6.90	3.0
	2	0.15	0.093	3.5	7.20	7.20	3.5
	3	0.10	0.062	2.8	6.95	6.95	2.0
	4	0.10	0.062	2.8	5.80	5.80	2.0
	5	0.15	0.093	3.5	7.10	7.10	2.5
	6	0.10	0.062	2.8	6.90	6.90	3.0
	7	0.10	0.062	2.8	3.40	3.40	1.5
	8	0.20	0.124	4.0	7.80	7.80	3.0
	9	0.15	0.150	4.5	8.10	8.10	2.5
	10	0.70	0.434	7.4	8.75	8.75	5.5
	11	0.10	0.062	2.8	5.50	5.50	2.0
Fig. 2 (Right) 0.0165 sec	1	0.30	0.186	4.8	13.9	13.90	4.0
	2	0.40	0.248	5.6	11.8	7.16	5.5
	3	0.30	0.186	4.8	14.7	8.52	5.0
	4	0.60	0.372	6.9	10.5	6.37	6.0
	5	0.80	0.496	7.9	12.4	7.52	5.0
	6	0.50	0.310	6.5	12.7	7.70	6.0
	7	0.60	0.372	6.9	12.6	7.64	5.0

Planimeter constant 10.25 for 10 sq in calibration scale

instrument measures to the 1/1,000 sec the time the shutter remains open after the synchrocircuit of the shutter triggers the flash lamp. This proved to be an unanticipated source of error in that the shutter set at 1/200 sec remained open for 0.010 sec ± 0.001 sec for a possible error of 10 per cent. The shutter remained open 0.016 sec ± 0.001 sec when set on 1/100 sec, which gives a possible 6.6 per cent error. This error could have been reduced had the pictures been made with an exposure of 1/25 sec, for at this speed the open time was 0.0215 sec ± 0.0005 sec, or with a possible error of only 2½ per cent.

The camera used in these investigations was a 4 x 5-in Speed Graflex with a Kodak Ektar 127 mm f/4.7 lens in a supermatic shutter with the built in X circuit for synchronized flash photography. The film used was for the large part Kodak Super Pan Press Type B film. Development of the negatives was the same as for normal daylight-exposed film in contrast to the 50 per cent overdevelopment that is recommended for film exposed with electrically discharged, gas-filled lamps, or as they are commonly referred to, "strobe" lights.

The oscillation of the drop shapes referred to earlier in this paper cause, in some of the drop paths, a difference in the light reflected, as shown by a fading of the sides. Close study of some paths shows a difference in the width of the paths that is the result of oscillation. In the enlargements of the three pictures there were 23 drops with images and paths of sufficient clarity to permit measurements, the summary of which is shown in Table 1. Based upon the conclusion drawn from Fig. 1, that the drops were circular around their axes of flight, the drop volume may be calculated to be the volume generated by the rotation of the sectional area around the axis of the path. The equivalent diameter of the drop was calculated from the relation $d = 2(A/\pi)^{1/2}$. The maximum axis column was obtained by direct measurements with the dividers of the drop paths and the meter scale.

Sources of Error. The principal sources of error in the preceding technique are from the inaccuracies of the camera shutter, the variation in the distance of the drops from the camera, and in the measurements of area of the drop images with a planimeter. The error in the shutter may be minimized by using longer exposures and a correspondingly smaller f opening. For the shutter used in this work this appears to be especially true due to a smaller numerical error at slow speeds which would result in a much smaller percentage error. Since the depth of the field of water passing across in front of the camera was restricted to a maximum of two inches, it is believed that the resultant error is negligible. The principal error from using the planimeter arises from the small sizes of the images to be measured and the slick surface of the enlarged photographs. An attempt to minimize the latter error was made by using the average of ten traverses around the perimeter as the measured area. It seems reasonable to estimate that future studies based upon this technique would be accurate within ± 5 per cent.

Recommendations for Further Study. An application of this technique to characterize a limited number of sprinklers in their recommended operating ranges would furnish a basis of correlation with direct measurements of the effects of these and other sprinklers on the soil. The measurements of effects on the soil should include studies of splash erosion, as well as surface sealing and compaction, as they affect infiltration rates and air permeability. From the viewpoint of economics, studies on the relation between minimum effect on the soil and pumping costs should be included.

CONCLUSIONS

1. The sizes and velocities of drops of water from irrigation sprinklers may be measured with reasonable accuracy by means of photographs.

2. By analysis of several photographs made at different distances from the sprinkler, an accurate description of the distribution of drop sizes and drop velocities could be obtained. These data would permit the mathematical calculation of the total impact forces that affect the soil per unit of time at a given rate of application. If these data were obtained, they could be correlated with pumping costs so the economic relationship might be established.

3. The technique described above used either alone or in conjunction with direct measurements of the effects of impact forces on the soil would permit a more complete description of sprinklers than is now used and would provide an improved basis for the selection of equipment best adapted to various soil and crop conditions.

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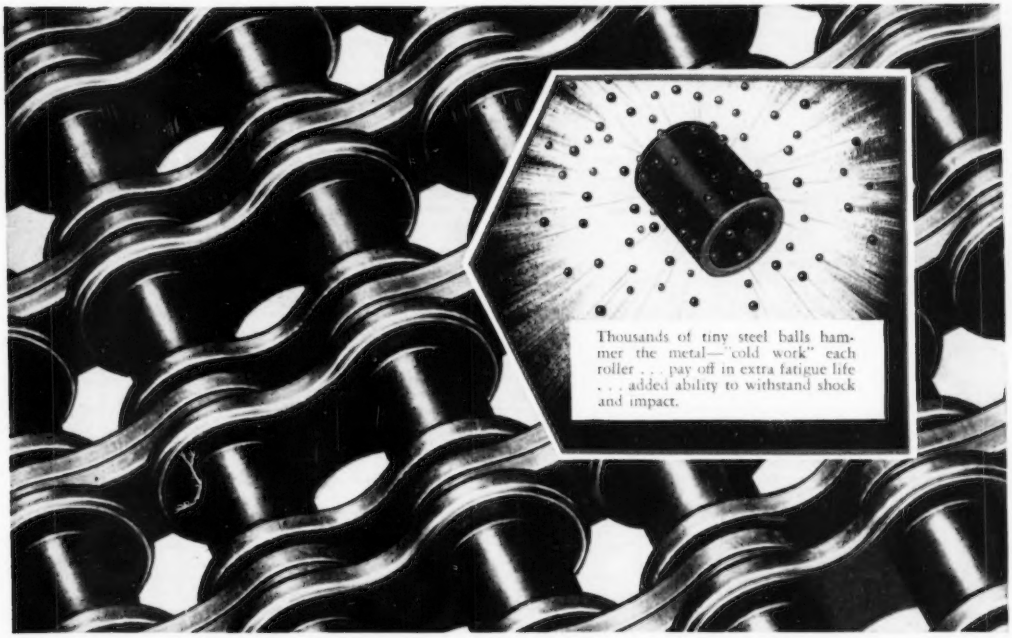
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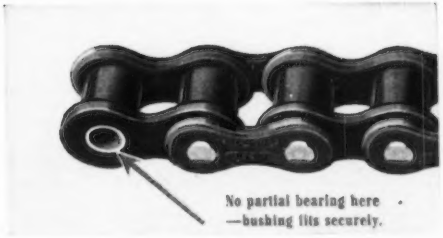

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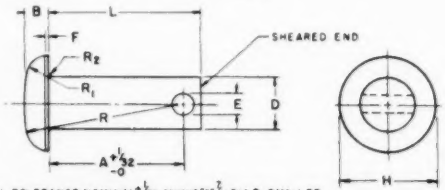

L TOLERANCE NOMINAL +1/32 MINUS "0" 7/16 DIA & SMALLER
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R_2 NOT TO EXCEED 1/32 FOR 7/16 DIA & SMALLER
R_2 NOT TO EXCEED 1/16 FOR 1/2 DIA. & LARGER

			1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
D	BODY DIAMETER	MAX	253	317	380	443	520	655	780	905	1.030
		MIN	244	305	365	428	478	600	725	.850	.975
H	HEAD DIAMETER		452	563	675	786	938	1.157	1.391	1.609	1.828
			422	529	637	.742	.875	1.093	1.312	1.531	1.750
B	HEAD THICKNESS		085	107	130	.152	.187	.234	.281	.328	.375
			101	125	150	.174	.218	.265	.312	.359	.406
F	FEED THICKNESS MAX.		017	021	024	.027	.030	.040	.045	.045	.045
	HEAD RADII	R	687	858	1.031	1.202	1.375	1.718	2.062	2.406	2.750
		R_1	125	156	187	.218	.250	.312	.375	.438	.500
E	HOLE SIZE		7/64	9/64	9/64	9/64	13/64	13/64	17/64	17/64	17/64

L											
1/2	A	DISTANCE TO HOLE	3/8	11/32	11/32	11/32					
5/8	A		1/2	15/32	15/32	15/32	13/32				
3/4	A		5/8	19/32	19/32	19/32	17/32	17/32			
7/8	A		3/4	23/32	23/32	23/32	21/32	21/32			
1	A		7/8	27/32	27/32	27/32	25/32	25/32			
1 1/4	A		1 1/8	1 3/32	1 3/32	1 3/32	1 1/32	1 1/32	1		
1 1/2	A		1 3/8	1 11/32	1 11/32	1 11/32	1 9/32	1 9/32	1 1/4		
1 3/4	A			1 19/32	1 19/32	1 19/32	1 17/32	1 17/32	1 1/2	1 15/32	1 15/32
2	A			1 27/32	1 27/32	1 27/32	1 25/32	1 25/32	1 3/4	1 23/32	1 23/32
2 1/4	A				2 3/32	2 3/32	2 1/32	2 1/32	2	1 31/32	1 31/32
2 1/2	A				2 11/32	2 11/32	2 9/32	2 9/32	2 1/4	2 7/32	2 7/32
2 3/4	A				2 19/32	2 19/32	2 17/32	2 17/32	2 1/2	2 15/32	2 15/32
3	A				2 27/32	2 27/32	2 25/32	2 25/32	2 3/4	2 23/32	2 23/32
3 1/4	A					3 3/32	3 1/32	3 1/32	3	2 31/32	2 31/32
3 1/2	A					3 11/32	3 9/32	3 9/32	3 1/4	3 7/32	3 7/32
3 3/4	A					3 19/32	3 17/32	3 17/32	3 1/2	3 15/32	3 15/32
4	A					3 27/32	3 25/32	3 25/32	3 3/4	3 23/32	3 23/32
4 1/4	A					4 3/32	4 1/32	4 1/32	4	3 31/32	3 31/32
4 1/2	A					4 11/32	4 9/32	4 9/32	4 1/4	4 7/32	4 7/32
4 3/4	A					4 19/32	4 17/32	4 17/32	4 1/2	4 15/32	4 15/32
5	A					4 27/32	4 25/32	4 25/32	4 3/4	4 23/32	4 23/32
5 1/2	A							5 9/32	5 1/4	5 7/32	5 7/32
6	A							5 25/32	5 3/4	5 23/32	5 23/32
6 1/2	A									6 7/32	6 7/32
7	A	DISTANCE TO HOLE								6 23/32	6 23/32

FARM INSTITUTE

REYNOLDS FARM INSTITUTE

P. O. Box No. 1800
Louisville 1, Kentucky

REYNOLDS FARM INSTITUTE PRESENTS A NEW COLOR MOTION PICTURE..."**BRIGHT HORIZONS**"

Adding visual education to other media of farm information, Reynolds Farm Institute is proud to make available for scheduled group showings a 16 mm. color motion picture entitled "Bright Horizons".

This is a film of scope and beauty, dignifying the most basic occupation of man. It pictures great advances made in agriculture and the bright horizons ahead ... horizons where the gleam of aluminum is seen increasingly, as farm buildings develop into more efficient farm tools.

Here the advantages of aluminum are brought out in true perspective, as among the many aids to greater farm production at lower cost. Greater production through aluminum's heat reflectivity ... keeping poultry and livestock cooler in summer, warmer in winter. Lower cost through the practical elimination of painting and maintenance, with rustproof aluminum.

County agents, vo-ag teachers and other agricultural leaders who wish to schedule a showing of "Bright Horizons" are invited to write to the above address.

REYNOLDS FARM INSTITUTE

DEPENDABLE PERFORMANCE

calls for STOW

Picture courtesy BROOME G. L. F. ELEVATOR

G.L.F. depends on STOW flexible shafting for speedy grain delivery!

"Since installing STOW flexible shafting on our bulk feed delivery units, we have lost no time due to breakdowns and have had no maintenance problems in over five months of continuous service", says Mr. Joseph Collins, manager, Broome G.L.F. Elevator.

This STOW flexible shaft application replaces a universal joint series which would not stand up under the rugged conditions to which it was subject during deliveries to farms. Primary cause of the failure, according to Mr. Collins, was the steep angles through which the universal joints had to operate. Prior to the installation of STOW flexible shafting, Broome G.L.F.'s grain delivery units suffered frequent breakdowns, each of which involved three or four-hour delays and upped delivery costs.

This is another excellent example proving the efficiency, the practicability of STOW flexible shafting. Why not consult with STOW engineers on *your* next power transmission problem?

WRITE TODAY for your FREE Torque Calculator and Bulletin 515 containing complete data on STOW flexible shafting. No obligation, of course.

STOW

first in flexible shafting since 1885

39 SHEAR STREET
BINGHAMTON, NEW YORK

PROPOSED ASAE RECOMMENDATION

Dairy Housing Terminology

IN THE interest of uniformity, together with attendant advantages, in the use of dairy housing terms, the American Society of Agricultural Engineers in 1950 responded to a request to set up the Committee on Dairy Housing Terminology, the purpose of which was to explore the possibilities of reaching general agreement on suitable terminology in this field. The Committee conducted a nation-wide survey which covered an extensive cross section of agricultural engineers and dairy husbandry specialists in the state agricultural colleges, extension services, and experiment stations and in the U.S. Department of Agriculture; manufacturers of dairy barn equipment, and city, state, and federal public health services. On the basis of returns from this survey, the Committee has submitted a number of terms, together with their definitions, for further consideration and eventual adoption as an approved ASAE recommendation for dairy housing terminology. Interested ASAE members are urged to suggest any changes in or additions to the Committee's recommendations; these should reach the ASAE headquarter's office, St. Joseph, Michigan, before November 1, 1952. Unless objections are raised, the recommendations of the Committee will in due course be formally adopted as an official ASAE Recommendation.

The proposed recommendations on dairy housing terminology as submitted by the Committee are as follows:

1. BARN. An enclosed covered building for the keeping and care of livestock and/or storage of dry roughages and bedding. It may include some but not necessarily all feed and bedding storages and feeding facilities for livestock.
2. SHED. A simple structure for shelter of livestock, storage of feeds, or both, and open on one or more sides. It may be separate from or attached to another structure.
3. LEAN-TO. A wing or extension of a building having a single pitched roof and usually projecting from a higher structure.
4. STALL BARN. A structure, sometimes referred to as a stanchion barn, for sheltering dairy cattle and/or young stock where the adult animals are confined to stalls by means of stanchions, straps, halters or chains during part of the year and usually for milking. Roughages and concentrates may be fed in mangers at the individual stalls. None, part, or all of feeds and bedding may be stored in the structure. Included are one or more rows of stalls and pens.
5. LOOSE HOUSING. A management system for dairy cattle wherein the adult animals are given access to a feeding area, a resting area, and an adjoining open lot. At milking time the lactating animals are passed through a milking room. Other dairy animals may be in separate pens, lots or buildings.
6. MILK AREA. An area which includes the milking room and milkroom (or milkhouse). Utilities (such as toilet, boiler room and heating plant, locker room) and office may be adjacent to or included in this area.
7. (a) MILKING ROOM. Sometimes called a milking parlor. A room where the cows are milked but not housed. It is an essential part of loose housing but optional with a stall barn.

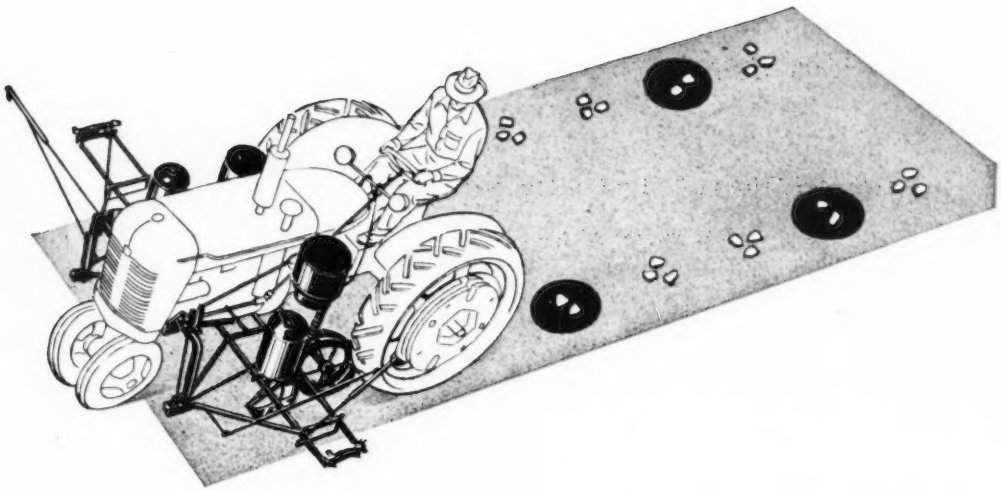
   (b) MILKING ROOM STALLS AND STALL ARRANGEMENTS.

   (1) Elevation with relation to floor level of operator area
      (A) Elevated
      (B) Floor level

   (2) Position of the stalls with relation to each other
      (A) Tandem: single or double in line, U-shaped, L-shaped, square, circular, etc.
      (B) Abreast

   (3) Method of entrance and exit
      (A) Side entering
      (B) Walk through
      (C) Back out

(Continued on page 574)



How the

McCormick Fertility-Level Planter

helps INCREASE Corn Yields

The McCormick clutchless check-row or hill-drop planter makes it possible to match corn plant population with available plant food. This promotes maximum yields in relation to soil fertility.

Planting too few or too many kernels in a hill reduces corn yields. The first extreme fails to utilize available plant food. The second may result in nubbins or barren stalks.

The number of kernels dropped in each hill is regulated by changing the rotating speed of continuous-running seed plates. This enables the planter to plant 1 and 2-kernel hills, or 2's and 3's, 3's and 4's, or 4's and 5's in practically any combination to match the fertility level of each field.

The McCormick clutchless check-row or hill-drop planter provides a completely new solution to a vexing farm problem. It is a typical result of progressive IH engineering that is helping to make farming a more profitable business, and a better way of life. A copy of the booklet—McCormick Forward-Mounted Corn Planters—which explains fertility-level planting in detail—is yours for the asking.

*POPULATION IN KERNELS PER ACRE	KERNELS PER HILL IN RATIO OF EVERY 100 HILLS	AVERAGE KERNELS PER HILL
7330	13 ones and 87 twos	1.87
7840	100 twos	2.00
8389	86 twos and 14 threes	2.14
8820	75 twos and 25 threes	2.25
9800	50 twos and 50 threes	2.50
11015	19 twos and 81 threes	2.81
11172	15 twos and 85 threes	2.85
11760	100 threes	3.00
12583	79 threes and 21 fours	3.21
15680	25 threes and 75 fours	3.75
15700	100 fours	4.00
16788	72 fours and 28 fives	4.28

*40 × 40-inch row spacing.

"SEE YOU AT THE POLLS!"

INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois

During the past fifty-five years we have watched many ambitious and enterprising manufacturers endeavor to copy the very extensive Oberdorfer line of bronze rotary gear pumps or present the world with their substitute.

It was not our business to notify these gentlemen that it would be financial suicide to try to duplicate the combination of quality and price so long associated with the name of Oberdorfer thruout the world. History is amply littered with the evidence.

There are available today many spray pumps more intricately designed, more delicately constructed and more costly to purchase and operate in the field.

Why gild the lily! Demand an inexpensive trouble free corrosive resistant bronze gear pump that accurately meters your spray formulations, positively, efficiently and at lowest cost per acre.

BUY *Oberdorfer*

Agricultural Pump Div., Oberdorfer Foundries, Inc.
1429 Thompson Rd., Syracuse, N. Y.

BRONZE OBERDORFER SPRAYING PUMPS

Dairy Housing Terminology

(Continued from page 572)

(c) Cow Alley. The area within the milking room required for the entrance and exit of cows to and from the milking-room stalls.

(d) Operator Area. The area within the milking room which is used by the personnel performing the routine milking operations.

8. Milkroom. A room with one or more sections for handling raw milk, wholly or partly enclosed by the structure in which the cows are milked.

9. Milkhouse. Same as milkroom, except that it is not a part of, but may or may not be connected with any other structures.

10. Pen Barn. A structure for sheltering and restricting dairy animals, which may be divided into pens for individual cows or groups of cows where they are bedded and fed.

11. Holding Area. A section of a barn, shed or open lot where cows are confined while awaiting their turn to be milked.

12. Feeding Area. An area of a barn, shed or open lot where cows are fed roughages, water and sometimes concentrates. This area may or may not include feed storages.

13. Resting Area (sometimes referred to as bedded, loafing or lounging area). A sheltered area of loose housing where cows are bedded but not fed. The manure pack is allowed to accumulate during all or a part of the year.

Terms Not Approved. It is recommended that certain terms be discontinued for one or more of the following reasons: (1) Not sufficiently descriptive; (2) convey the wrong meaning; (3) insufficient agreement and too much confusion in different areas regarding their true meanings; (4) better, simpler, more descriptive terms or words are offered. These terms are as follows: (a) Tramp shed, (b) loafing barn, (c) loose-run barn, (d) loose stabling, (e) lounging barn, (f) milking parlor, (g) pen stabling, (h) stanchion barn, (i) bedded area.

What Do Standards Accomplish?

THE co-ordination of basic designs and the simplification of practices involved in the production of similar articles contribute largely to the elimination of economic waste. It also permits reduction of a large proportion of dormant capital tied up in the stocks of the manufacturer, the jobber, and the retailer.

Standards have four distinct values, as follows:

(a) They educate by setting forth quality goals for the guidance of producers and consumers alike.

(b) They simplify by limiting the number of sizes, the variety of processes, the amount of stock, and the associated paper work — thus reducing the overhead costs of manufacturing and selling.

(c) They conserve by cutting down the losses, wastage, and unnecessary tooling that accompany odd-lot manufacture, thus promoting large-scale production of standard design.

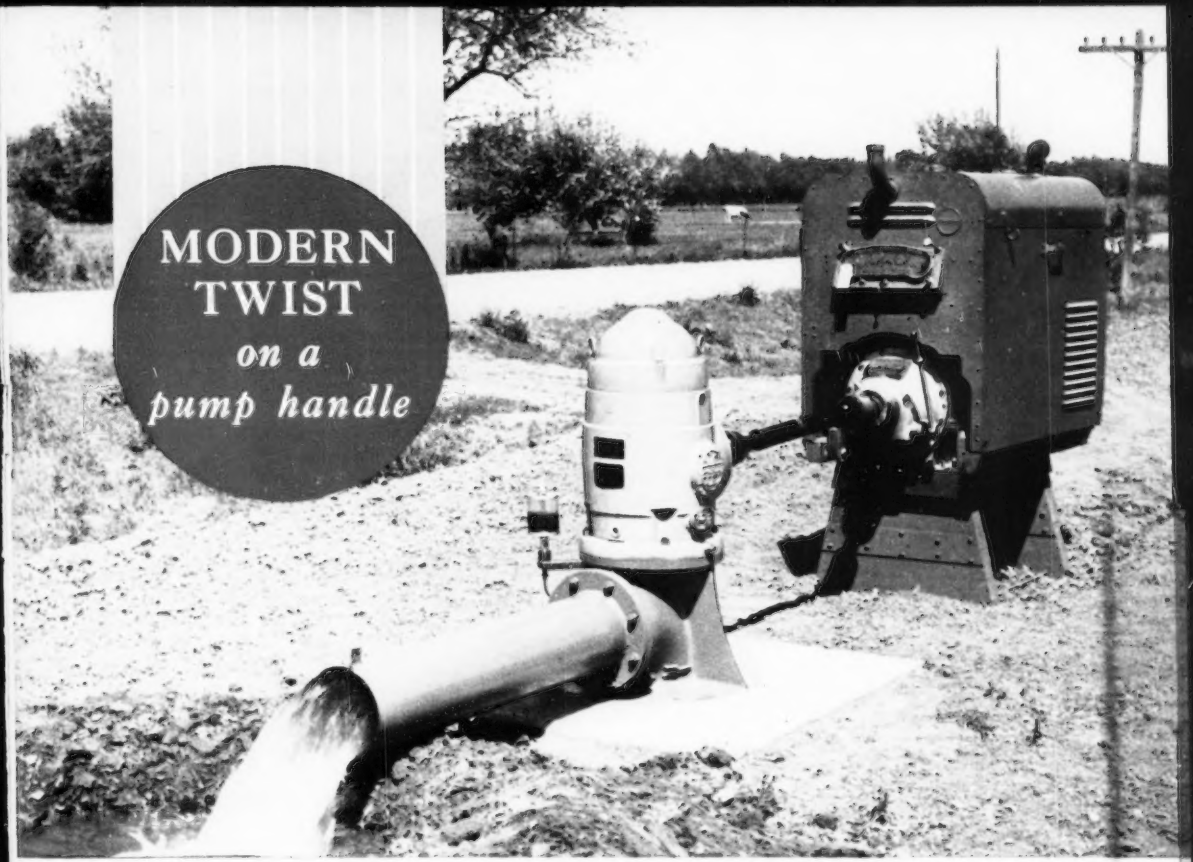
(d) They certify by serving as hallmarks of quality and value.

In brief, standards make it possible to provide more goods at lower costs, and enable buyers to determine and evaluate the goods that they require. — W. R. McCaffrey in *Mechanical Engineering* for August, 1952.

What Is Security?

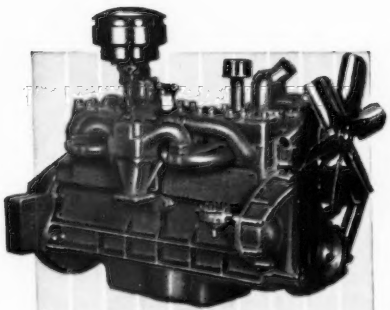
REAL security may be defined as a house with five sides, four of which have nothing to do with wealth or money or economics. The five sides are spiritual security, which is faith in Divine guidance; physical security, or the ability to plan for the future with reasonable expectation of living to enjoy it; political security — or simply freedom; psychological security or really just plain confidence in yourself; and finally economic security. — Benjamin F. Fairless, chairman, Board of Directors, U.S. Steel Corporation.

MODERN TWIST *on a pump handle*



Photo—Courtesy Western Land Roller Co., Hastings, Nebraska

discharges 1050 gallons of water a minute from 100 feet down!



This 8-inch Deep Well Turbine Pump is furnishing water for irrigation purposes near Hastings, Nebraska. It is powered by a Model 8-A Chrysler Industrial Engine with right angle gear drive.

This is Chrysler high speed and Chrysler high compression doing a specialized job. Other farming, construction, industrial and specialized applications are no exception to this kind of regular performance. Here are a few of the advantages you get in Chrysler Industrial Engines: superfinished wear surfaces, sodium cooled exhaust valves, updraft or downdraft carburetion—and there are many more tailored to the exact needs of your job.

Chrysler Industrial power is not expensive. Production-line methods adapted to specialized industrial engine building, provide a custom-built engine at mass production prices.

See a Chrysler Industrial Engine Dealer. Tell him your power needs. He can supply you with one of 9 Chrysler Industrial Engines for your purposes.

If your problem is special, write us direct: **Marine and Industrial Engine Division, Chrysler Corporation, 12200 E. Jefferson Ave., Detroit 31, Michigan.**

CHRYSLER

Industrial Engines

HORSEPOWER WITH A PEDIGREE

NEWS SECTION

ASAE Meetings Calendar

October 9 and 10—PENNSYLVANIA SECTION, Penn Wells Hotel, Wellsboro, Pa.

October 11—OHIO SECTION, Ives Hall, Ohio State University, Columbus.

October 21—MINNESOTA SECTION, Agricultural Engineering Bldg., University of Minnesota, University Farm, St. Paul.

October 25—MICHIGAN SECTION, Agricultural Engineering Bldg., Michigan State College, East Lansing.

October 30–November 1—PACIFIC NORTHWEST SECTION, Oregon State College, Corvallis.

December 15-17—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

June 15 to 17—16TH ANNUAL MEETING, Hotel William Penn, Pittsburgh, Pa.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Michigan.

ASAE Section Meetings in October

UP TO the time of going to press with this issue, announcements have been received of five meetings of ASAE Sections during the month of October.

The Pennsylvania Section will hold a two-day meeting, October 9 and 10, at Penn Wells Hotel, Wellsboro, Pa.

The Ohio Section announces that it will hold a one-day meeting in Ives Hall on the Ohio State University campus, Columbus, on Saturday, October 11. The forenoon session will be devoted to two subjects, the first on ventilation of stables will be handled by C. Howard Bingham, Pennsylvania representative for New Way Farm Sales, Inc. The second subject will be on water problems to be discussed by a representative of the Milwaukee office of the U. S. Soil Conservation Service.

The Minnesota Section announces a meeting for Tuesday, October 21, which will be held in the Agricultural Engineering Building on the University of Minnesota Farm campus at Saint Paul.

On Saturday, October 25, a meeting of the Michigan Section is scheduled to be held in the Agricultural Engineering Building at Michigan State College, East Lansing.

The Pacific Northwest Section will hold its meeting this year—October 30 to November 1—on the Oregon State College campus at Corvallis.

ASAE Michigan Section Meets in October

THE fall meeting of the Michigan Section of the American Society of Agricultural Engineers will be held in the agricultural engineering building on the Michigan State College campus, East Lansing, on Saturday, October 25. The forenoon will be devoted to a technical program, followed by a luncheon, both of which will be in the agricultural engineering building.

Of particular interest to MSC alumni will be the homecoming football game in the afternoon, with Penn State as the opposing team. According to the Section secretary, Robert G. White, good seats for the game will be made available to Section members shortly after Sept. 15; write him at the agricultural engineering building, MSC, East Lansing.

New Officers of ASEE Agricultural Engineering Division

AS THE result of the recent election by mail ballot, the agricultural engineering division of the American Society for Engineering Education has elected the following officers for the ensuing two-year period: Chairman, Orval C. French, head, agricultural engineering department, Cornell University; vice-chairman, R. H. Driftmier, chairman, agricultural engineering department, University of Georgia; and secretary, Frank B. Lanham, assistant secretary, ASAE.

Literature Needed in Columbia

TWO members of ASAE—C. M. Hansen and M. L. Bailey—who are on leave from the agricultural engineering department of Michigan State College—assisting two schools of Columbia to establish agricultural engineering work, report that these schools are in dire need of agricultural engineering literature for their libraries. If any ASAE members who have recent issues of AGRICULTURAL ENGINEERING they do not wish to retain for reference use, the schools referred to would welcome them. Copies may be shipped addressed to C. M. Hansen, Agricultural Engineering Department, Michigan State College, East Lansing, for forwarding.

(News continued on page 578)

4 Way Shock Protection

NO. 1753 MOHAWK CONTOUR

Genuine LEATHER

New MILSCO "Mohawk"

Engineered for Comfort — Streamlined for Sales Appeal

Milsco proudly presents the new "Mohawk" . . . padded with thick foam rubber, covered with high grade black flexible leather, the new Milsco "Mohawk" gives you extra comfort, extra safety. Extra heavy steel base.

Left to right .....22"
Front to rear .....21½"

Milsco MILWAUKEE

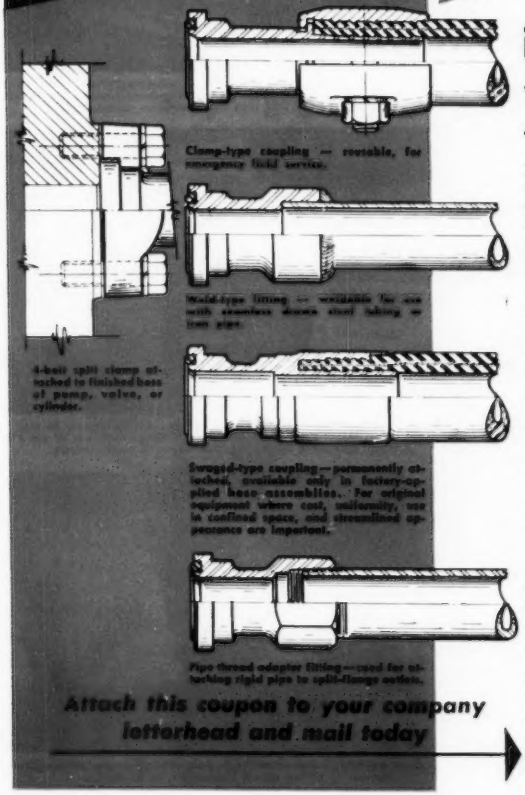
MILSCO MFG. CO.
2732 N. Thirty-third St.
Milwaukee 45, Wis.

Write for Catalog on Company Letterhead

Stop Leaks... Eliminate Threaded Joints

in hydraulic hose assemblies

with this revolutionary, easy-to-use ANCHOR SPLIT-FLANGE CLAMP


Clamp-type coupling — reusable, for emergency field service.
Weld-type fitting — available for use with seamless drawn steel tubing or iron pipe.
4-bolt split clamp attached to finished boss of pump, valve, or cylinder.
Swaged-type coupling—permanently attached, available only in factory-applied hose assemblies. For original equipment where cost, uniformity, use in confined space, and streamlined appearance are important.
Pipe thread adapter fitting—used for attaching rigid pipe to split-flange outlets.

Here's a brand new time- and trouble-saver for the users of hydraulic hose and piping — Anchor's exclusive Split-Flange Clamp. Check these features — they're what you've been looking for.

LEAKPROOF — the "O" ring, successfully utilized in so many hydraulic applications, provides a perfect seal.

EASY TO ASSEMBLE — no unwieldy pipe wrench required. All you need is a small automotive type wrench. Ideal where clearances are limited.

ELIMINATES PIPE THREADS—can easily be removed or attached over and over again. No tapered threads or wedging action to cause distortion in pump housings, cylinders, or valve bodies.

WIDE RANGE OF SIZES AND TYPES — straight or angle styles with clamp or pressed-on couplings — sizes from ½-inch ID to 2-inch ID. Available for high, medium, or low-pressure service and suction return lines. Send coupon for further information.

ANCHOR COUPLING CO. INC.

Factory: LIBERTYVILLE, ILLINOIS • *Branch:* DETROIT, MICHIGAN

Attach this coupon to your company letterhead and mail today

ANCHOR COUPLING CO. INC., Dept. AE-92
Libertyville, Ill.

Yes, I'm interested in Anchor Split-Flange Clamps.
Please send me a bulletin with more information.

Name ..... Position .....

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Company Address .....

City ..... ( ) State .....

D-52

GALVANIZED SHEETS

For PROTECTION Only galvanized sheets give you the strength of steel . . . the rust protection of zinc. Both are important in providing a strong, sound, leak-proof roof that double-guards valuable crops, livestock and machinery against damage and destruction for years and years. It's the first choice of farmers.

For STAYABILITY Galvanized roofing holds at the nail holes . . . stays leak-proof and solid year after year with a minimum of maintenance. Farmers say it cuts down overhead by staying "overhead"—often for the life of the building.

For ECONOMY Consider the economy of any roofing material with these three long-time cost factors in mind: (1) original price; (2) repair and upkeep; (3) years of serviceable life. Galvanized sheets are first choice of farmers because they know that the roof that gives them the longest, trouble-free service is the cheapest in the long run.

DON'T FORGET

Proper care pays! Material shortages are limiting new construction and replacement. Careful maintenance of present structures is more essential now than ever before. Expanding production of zinc and steel means ample supplies of galvanized sheets with the return of more normal conditions. In the meantime, a few simple steps with very little labor can extend the useful life of your galvanized roofing. The valuable booklets described below will tell you how.

ZINC INSTITUTE
2 OZ. COATING
SEAL OF QUALITY

SEND FOR VALUABLE BOOKLETS

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Without cost or obligation, send the illustrated booklets I have checked.

- ☐ Facts About Galvanized Sheets
- ☐ List of Metallic Zinc Paint Mfrs.
- ☐ Directions for applying Galvanized Sheets
- ☐ Repair Manual, on Galvanized Roofing and Siding
- ☐ Use Metallic Zinc Paint to Protect Metal Surfaces

NAME_____

ADDRESS_____

TOWN AND STATE_____

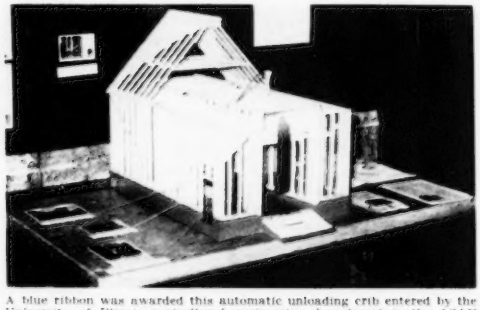
 (Continued from page 576)

ASAE Extension Exhibits

THE exhibits arranged by the ASAE Committee on Extension were prominent in both number and quality at the Society's annual meeting at Kansas City in June. F. W. Andrew, University of Illinois, was in charge of the demonstration model exhibits which included both portable and semiportable displays. In the former class, C. V. Phagan, Oklahoma A. & M. College, won an award for his head gate model and was, in addition, cited by the Committee on Safety for his exhibit. Other winners in the portable display class included the department of agricultural engineering, University of Illinois, for an automatic unloading crib model, and C. E. Worlan, Iowa State College, for a display on septic tank and sewage disposal standards.

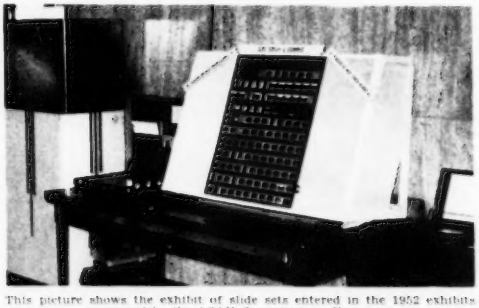
In the semiportable display class, J. I. Case Company won an award for their water-spreading exhibit.

Headed by M. R. Dunk, the Better Bulletins Committee announced winners in four classes of competition. In the "public agency" category, "Planning the Farm Home Wiring System," issued by the Southern Association of Agricultural Engineering and Vocational Agriculture, carried away first honors, followed by the University of California for their publication, "Cooling and Handling Eggs on the Ranch," and "Sprinkler Irrigation," a publication of the Pacific Northwest Cooperative Extension. (News Section continued on page 580)

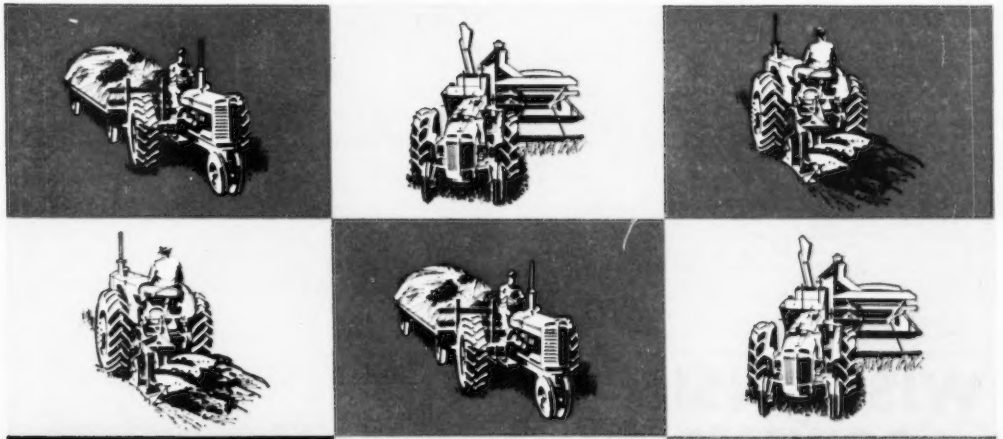


A blue ribbon was awarded this automatic unloading crib entered by the University of Illinois agricultural engineering department in the ASAE Extension Committee's 1952 demonstration models exhibit

C. V. Phagan, Oklahoma A & M College, won a safety award, as well as a ribbon, on this head gate in the demonstration models class of the 1952 exhibits sponsored by the ASAE Committee on Extension



This picture shows the exhibit of slide sets entered in the 1952 exhibits sponsored by the ASAE Committee on Extension



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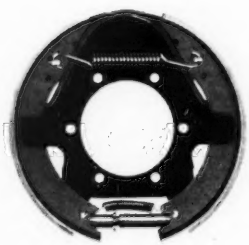
Farm Tractor Brakes...

backed by the greatest name in braking



The Bendix heavy-duty farm tractor brake has powerful and positive holding action in both forward and reverse. Rugged design assures uniform performance day after day, under the most severe field and road work.

For 25 years Bendix has specialized in building brakes for the automotive industry. In that period of time the Bendix Products Division at South Bend has built more than 90 million brakes for passenger cars, trucks and farm tractors.

These are reasons why tractor manufacturers—as well as passenger car and truck manufacturers—look to Bendix as brake headquarters.

Bendix Brakes for farm tractors are specifically designed for the exacting needs of this class of service, combining rugged, dependable and smooth action with low cost. That's why Bendix Brakes are the logical choice for the modern tractor.

Let Bendix® farm tractor brake engineers help you solve your brake problems. Write for detailed information.

®REG. U.S. PAT. OFF.

BENDIX • PRODUCTS DIVISION • SOUTH BEND

Bendix AVIATION CORPORATION

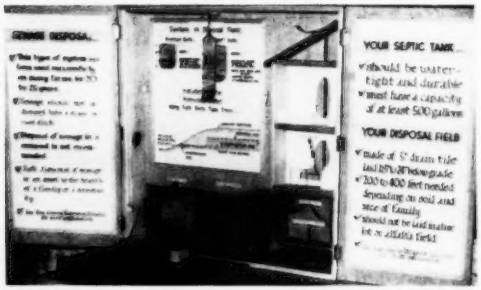
EXPORT SALES:

Bendix International Division, 72 Fifth Ave., New York 11, N. Y. • Canadian Sales: Bendix-Eclipse of Canada, Ltd., Windsor, Ontario, Canada

In the industrial bulletin group, the American Petroleum Institute placed first with "Power Farming, A Way of Life." "Land of Plenty," published by the Farm Equipment Institute, and "How to Build Buildings that Last Longer," a publication of the West Coast Lumbermen's Association, placed second and third, respectively.

Two winners were named in the display of classroom manuals, prepared by public agencies. Top honors were taken by the State College of Washington for the publication, "Farm Electrification for Rural Youth," followed by a second-place winner, University of Idaho, for the publication, "4-H Club Farm Electrification." In the industrial class, covering classroom manuals, the judges gave first place to "Farm Water Systems Power Use Program," issued by the Iowa Rural Electric Cooperative Association. Placing second was the Wisconsin Electric Company with their publication, "Practical Exercises with Electricity as Used on the Farm."

Featured for the first time this year was a poster and chart exhibit. G. E. Henderson, University of Georgia, substituting for Chairman G. I. Johnson, announced two award winners, the J. I. Case Company for the exhibit, "Contour Farming Pays Three Ways," and the University of Illinois for the display, "Remodeling the Model T Farm House."



This septic-tank and sewage-treatment model prepared by C. E. Worlan, Iowa State College, won a ribbon in the ASAE Extension Committee's 1952 exhibit of demonstration models.

S. S. DeForest, associate editor of "Successful Farming," exhibited a lighted rack of slides which attracted attention. Winning groups of slides were submitted by the Portland Cement Association, entitled "Concrete Floors for Farm Buildings," and by Iowa State College for a series on "Mechanical Drying of Ear Corn."

Blue ribbon motion pictures, announced by J. J. McKitrick, University of Kentucky, for Chairman I. D. Mayer, Purdue University, were, first, "Farm Tractor Safety," prepared by the American Petroleum Institute, and, second, "Dawn of Better Living," a release of the Westinghouse Electric Corporation.

A new activity this year was a display of agricultural engineering information newsletters. Several exhibits were on display.

A special feature provided for those interested in extension activities was provided by Eugene Carrington of Allied Radio Corporation. A demonstration on the technique of using sound equipment was presented at a special meeting of the Committee on Extension and an explanation made of how depth or three-dimensional sound is recorded and duplicated. Practical applications of this technique, such as is used in determining the locations of sounds coming from a mechanism, were demonstrated. Mr. Carrington commented upon the far-reaching effects of this technique as it doubtless will be related in the near future to entertainment features.

In addition to the activities sponsored during the ASAE annual meeting, the Committee on Extension is anxious to further serve the Society as a means of exchanging information and teaching techniques throughout the year. There are undoubtedly many ASAE members representing trade associations, industry and public agencies whose activities within this Committee would be of mutual value. The Committee invites ideas from all sources toward more effectively bringing to farm people engineering information.

Pittsburgh Calling

AT THE present rate of planning and activity, the Society may look forward to a most successful 1953 Annual Meeting in Pittsburgh. The Local Arrangements Committee, capably led by Parker Hess, seems to be considering every feature which will add to the value of the meeting. A special effort is being made to attract a large student attendance as well as ASAE family groups.

Pittsburgh, known as the workshop of the world, is the seat of many of America's most dominating industries. Its situation is in one of the richest mineral sections of the world, and few cities can boast of a richer history. Pittsburgh is a city of friendly folk — in fact, it is the city for all ASAE members, their families, and guests to see in June, 1953.

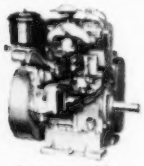
(News continued on page 586)

WISCONSIN-POWERED HOWRY-BERG Spiral Loader

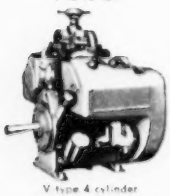
POWER TO FIT THE MACHINE

POWER TO FIT THE JOB

4 cycle single cylinder models 3 to 9 hp.



2 cylinder models 7 to 13 hp.



V-type 4 cylinder models, 15 to 30 hp.

This efficient Spiral Loader, available in lengths from 19 to 41 ft., transfers up to 17 bushels of small grain or shelled corn per minute, spouting it from bin to truck. This versatile unit can also be used for handling bulk cement from railroad cars to cement batching plants or on new construction jobs. A product of the Howry-Berg Steel & Iron Works, Inc., Englewood, Colo., who recognize the value of Wisconsin Air-Cooled Engine power for utmost dependability and most complete adaptability to the equipment.

Such features as extremely compact design, light weight, heavy-duty construction and all-weather AIR-COOLING adapt Wisconsin Engines to a great variety of equipment applications. And the wide choice of types and sizes, from 3 to 30 hp., in single cylinder, 2- and 4-cylinder models permits the selection of a power unit that delivers *exactly the right power to fit the machine and the job . . .* without power waste and with utmost service benefits.

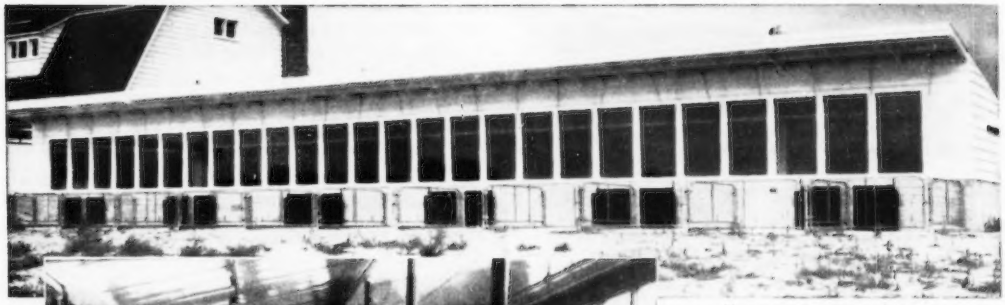
More and more designing engineers and power-wise farmers are today specifying "WISCONSIN AIR-COOLED ENGINES" . . . fully described and illustrated in the booklet, "Power Magic", which is yours for the asking.

WISCONSIN MOTOR CORPORATION

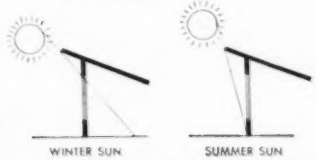
World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 7252-3$_2$



Hog house located at Michigan State College, East Lansing.



TURN SUNLIGHT ON AND OFF

These diagrams show how an overhang shades the windows from the high summer sun—but admits the winter sun which is lower in the sky. L·O·F has developed a Sun Angle Calculator to help you compute sun problems, such as sun penetration into buildings, solar heat gain, and shading devices. Available at $9.50. Write for further information.

NEW HOG HOUSE USES WINTER SUN FOR WARMTH AND SANITATION

Large windows face south to bring in winter sun. Solar heat and the sun's germicidal effect together produce an ideal environment for farrowing. It makes possible the use of a central farrowing house, with consequent labor saving.

More sun and animal heat are kept *in* this hog house by the use of *Thermopane** insulating glass. This is an especially important feature during cold snaps and cold nights. *Thermopane* cuts in half heat loss through glass. It reduces condensation on the glass, keeping windows cleaner to admit more sunlight.

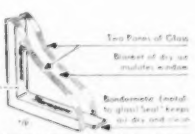
Thermopane insulating glass makes buildings more comfortable to work in. It aids moisture control because with warmer air, ventilating systems are able to carry off more moisture. This reduces rot and rust.

You can now get Farm *Thermopane* for lower-cost double glazing of service buildings. It is made with heavy sheet glass, not plate glass. It has the same time-proved, metal-to-glass *Bondermetic Seal** that has been proved in more than 2,500,000 *Thermopane* insulating glass units. It has a $\frac{1}{2}$" blanket of dry air between the panes. Farm *Thermopane* comes in three sizes—36" x 44", 36" x 60" and 40" x 68". Smaller units for ventilating sash have $\frac{1}{4}$" air space. *Thermopane* is sold by glass and building supply distributors and dealers. Mail the coupon for full information.

L·O·F GLASS — PLANOLITE — FIBER GLASS

Thermopane

LOOK FOR THE NAME ON THE SEAL BETWEEN THE PANES



FREE FOLDER

"IMPROVED FARM BUILDING DAYLIGHTING"

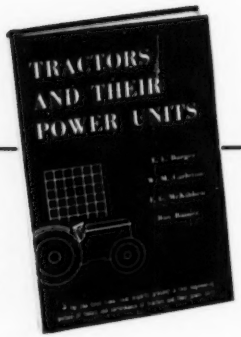
Libbey·Owens·Ford Glass Co.
1892 Nicholas Bldg., Toledo 3, Ohio

Please send me a free copy of "Improved Farm Building Daylighting".

Name _____
(PLEASE PRINT)

Address _____

Town _____ State _____



"OUTSTANDING JOB"

TRACTORS

AND THEIR

POWER UNITS

By E. L. BARGER, W. M. CARLETON, E. G. McKIBBEN, and R. BAINER

"delighted to recommend it"...

"... a distinct contribution to the literature of farm tractor engineering, and all of us in the industry stand to benefit by its publication. I shall be delighted to recommend it ... to anyone who may inquire regarding an authoritative text on this phase of agricultural engineering."

W. H. WORTHINGTON
Director of Engineering Research
John Deere Waterloo Tractor Works

Sponsored by the Ferguson Foundation

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PERSONALS OF ASAE MEMBERS

HAINES E. BELLMAN, a recent graduate in agricultural engineering of Ontario Agricultural College, is now employed as a field man by the department.

GEORGE R. BOYD recently retired from his work in the U. S. Department of Agriculture, where he was head of the division of mechanical processing of farm products. He has been a member of ASAE for the past 30 years. WILBUR M. HURST has been promoted to succeed Mr. Boyd as head of the division.

JOSEPH P. COLTORTI has been transferred from his position as chief of operations, Lower Colorado River District, USDI Bureau of Reclamation, to a position of head of irrigation operations of the Big Horn District of the Bureau at Cody, Wyo.

GEORGE W. CROWTHER has resigned as assistant professor of agricultural engineering, University of Connecticut, to become agricultural engineer for Yankee States Distributors at Storrs, Conn.

HERMAN W. GLOVER has been promoted to assistant extension agricultural engineer of the Virginia Agricultural Extension Service, Blacksburg.

RICHARD F. HARRINGTON, is employed as district engineer of the Bearings Company of America and is located at Davenport, Iowa.

RAYMOND H. HELLER recently accepted a position with the Robert Shaw Fulton Controls Co., Anaheim, Calif. His new address is 848 Olive Ave., Long Beach, Calif., care of Mrs. Anna Heller, Apt. 2. He was formerly experimental engineer at the John Deere Dubuque Tractor Works.

K. M. HICKMAN was recently promoted from the position of manager of agricultural sales to assistant sales manager of the Ewart plant of Link-Belt Company at Indianapolis, for general products of that plant. He has been with the Link-Belt Company since 1927.

ROBERT F. U. ICELY, formerly assistant combine engineer, Massey-Harris, Ltd., is now employed as process engineer for Dominion Tar and Chemical Co. at Montreal.

MARK H. KIRKPATRICK, JR., formerly agricultural engineer in the research division of the U.S. Soil Conservation Service at Blacksburg, Va., is now in the employ of the International Harvester Company, and is located at Greensboro, N. C.

CALVIN K. MUTCHLER is employed as instructor in the agricultural engineering department of the University of Connecticut, Storrs.

F. E. PRICE, dean of agriculture, Oregon State College, and CRAWFORD REID, sales manager, National Rain Bird Sales and Engineering Corp., have accepted an invitation to spend two months in Brazil beginning in September, in consultation on sprinkler irrigation, especially as related to coffee production. The invitation was received from the secretary of agriculture of the state of Sao Paulo, on behalf of the Institute da Agronomico. Mr. Reid will deal with engineering phases of irrigation development and practice, and Dean Price will be concerned with educational facilities to meet requirements for training personnel in various phases of irrigation work.

EDD D. RHOADES was recently transferred from the Soil Conservation Service, USDA, as supervising agricultural engineer, to the U.S. Naval Ammunition Depot, McAlester, Okla., as civil engineer (soil mechanics) to be in charge of the soil conservation program being undertaken by the Depot personnel. The project is under the technical supervision of the Bureau of Yards and Docks, U.S. Navy.

FRED W. ROTH has resigned as a member of the agricultural engineering staff, University of Maine, to accept employment at the Southern Illinois University, Carbondale, where he will handle the agricultural engineering phases of the work in the institution's department of agriculture.

CARL RUDMAN, who joined Link-Belt Company in 1937, and who since 1948 has specialized in the application of Link-Belt chain and sprockets to farm machinery, was recently appointed manager of agricultural sales at the Ewart plant of the Company in Indianapolis to succeed K. M. Hickman.

NORMAN C. TETER recently accepted a position with the farm building and rural housing division (BPISAE), U.S. Department of Agriculture, and is located at the Tidewater Experiment Station, Holland, Va. He was formerly associate agricultural engineer, North Carolina State College.

FRED A. WIRT, advertising manager, J. I. Case Company, Racine, Wis., and a past president of ASAE, addressed the agricultural engineering section of the Agricultural Institute of Canada at its 32nd annual convention in June, on the subject "The Tractor Down Through the Years." This is a most interesting history of the development of the tractor and its impact on the agriculture of the United States and Canada. Copies of the address can be obtained on request direct to Mr. Wirt.

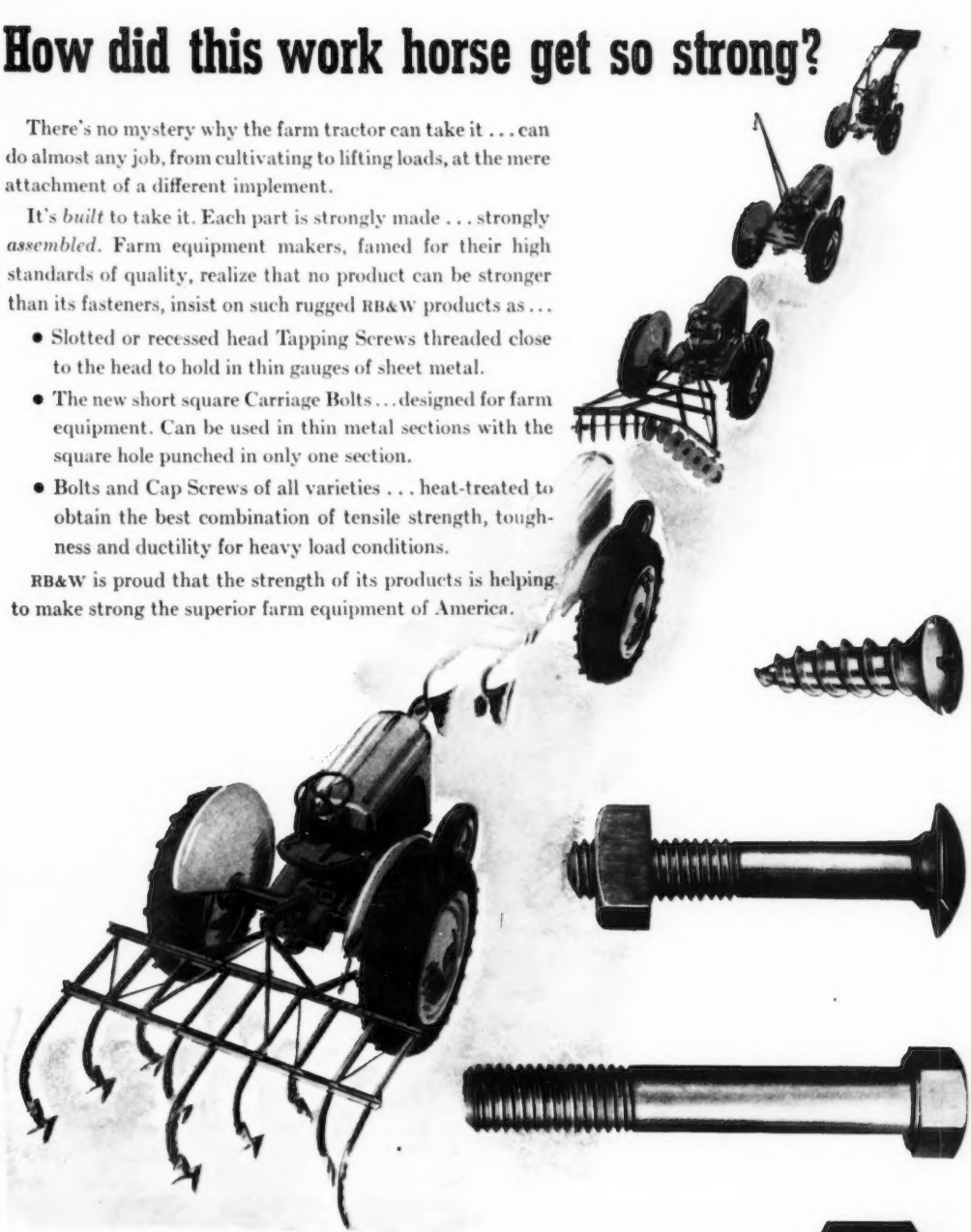
How did this work horse get so strong?

There's no mystery why the farm tractor can take it . . . can do almost any job, from cultivating to lifting loads, at the mere attachment of a different implement.

It's *built* to take it. Each part is strongly made . . . strongly *assembled*. Farm equipment makers, famed for their high standards of quality, realize that no product can be stronger than its fasteners, insist on such rugged RB&W products as . . .

- Slotted or recessed head Tapping Screws threaded close to the head to hold in thin gauges of sheet metal.
- The new short square Carriage Bolts . . . designed for farm equipment. Can be used in thin metal sections with the square hole punched in only one section.
- Bolts and Cap Screws of all varieties . . . heat-treated to obtain the best combination of tensile strength, toughness and ductility for heavy load conditions.

RB&W is proud that the strength of its products is helping to make strong the superior farm equipment of America.



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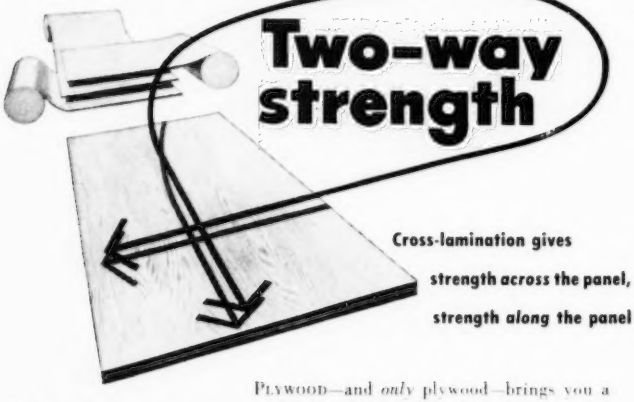
THE COMPLETE QUALITY LINE

Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Dallas, Oakland. Sales agents at: Portland, Seattle.

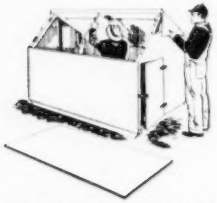
106 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

Only Plywood Brings You *All* The Advantages of



For New Buildings . . .
For Maintenance, Repair

Plywood farm structures are strong, rigid, tight, draft-free. Plywood's two-way panel strength means you can build with fewer framing members.



Large, light panels . . . easy to handle and work . . . save time on all your maintenance and repair jobs. No special tools are needed!

Plywood buildings are light, yet rigid. Portable buildings of plywood move easily, won't rack apart. Two-way panel strength saves you work and worry.

Plywood is ideal for farm homes—remodeling, too. Can't be beat for cabinets, built-ins, paneling . . . for sheathing, subflooring, siding. Ask your retail lumber dealer!

PLYWOOD—and *only* plywood—brings you a modern panel material that is:

- Large Size
- Light Weight
- Real Wood
- Easy to Work
- Durable*
- Splitproof
- Puncture-proof
- Kick-proof
- Extra Strong
- Extra Rigid

Yes, only plywood combines *all* these important advantages. Here's why:

Wood is *extra* strong along the grain. Plywood is a cross-laminated panel of real wood—permanently bonded—with the grain of alternate plys running in opposite directions. In plywood, the natural grain-strength of the wood works *two ways*.

Plywood's unique advantages make it the all-purpose farm material. Anyone can work with plywood; only ordinary skill and ordinary carpentry tools are needed. Plywood cuts building time as much as 50% . . . means stronger, more rigid construction, long-time investment value.

Learn more about plywood's farm advantages. Write for 28-page booklet, *Better Farm Buildings With Exterior Plywood*. Send 10c to Douglas Fir Plywood Association, Tacoma 2, Washington.

*Durable EXTERIOR-TYPE plywood can even be boiled in water! It's made with 100% waterproof glues. Use EXTERIOR for all farm service buildings; the registered EXT-DFPA on the panel edge is positive identification. Inside the farm home, use interior-type Douglas fir plywood. Ask your retail lumber dealer!

Douglas Fir

Plywood

AMERICA'S BUSIEST BUILDING MATERIAL

Large, Light, Extra-Strong Panels of Real Wood

Applicants for Membership

The persons listed below have applied for admission to membership or for transfer of membership grade, in the American Society of Agricultural Engineers. Members of the Society who wish to comment or object to any of these applicants, should write the Secretary of the Society at once.

AMERIKS, ARTURS R.—Trainee, product engr. dept., J. I. Case Co., Rockford Works, Rockford, Ill.

BAKER, EARL B.—Farmer, R.R.1, Baxley, Ga.

BASSELMAN, JAMES A.—Assistant editor, Farm Implement News, 608 S. Dearborn St., Chicago 5, Ill.

BEAUDET, JACQUES H.—Technical advisor, Shawinigan Water & Power Co., 600 Dorchester St., W., Montreal, P. Q., Canada.

BEELER, MAXWELL N.—Agricultural counselor, Capper Publications, Inc., Topeka, Kans.

BIUBO, BILL C.—Repairman, Hiedrick Bros., Road 97, Woodland, Calif.

BRILL, GEROW D.—Project supervisor, (SCS), USDA, div. of research, New Brunswick, N. J.

BUCKLEY, EDWIN J.—Engineer, Dravo Corp., Fifth & Liberty Ave., Pittsburgh 22, Pa.

CROISANT, ELMER E.—Tool supervisor, Wisconsin Axle Div., Timken-Detroit Axle Co., 567 High St., Oshkosh, Wis.

EDGERLEY, WILLIS F.—Rural architect, (BPISAE), USDA, Div. of Farm Bldgs. & Rural Housing, Agricultural Research Center, Beltsville, Md.

EVERSON, RAYMOND I.—Extension architect, engr. ext., Kansas State College, Manhattan, Kans.

HARSTICK, W. H.—Chief engineer, dairy equipment dept., International Harvester Co., McCormick Works, Blue Island & Western Ave., Chicago 8, Ill.

HAUSER, VICTOR L.—Assistant superintendent, Irrigation Experiment Station, Oklahoma A & M College, Stillwater, Okla.

HESTER, MARLYN F.—Process control man, Lone Star Cement Corp., Demopolis, Ala.

HUDNALL, JOHN W., III—Assistant design engineer, Southwest Equipment Co., 919 S. Ervay St., Dallas, Texas.

HURD, PHILLIP F.—Sales engineer, Thomas Hydraulic Speed Controls, 1320 S. McLean, Wichita, Kans.

KAMPE, DWIGHT F.—Graduate student, agr. engr. dept., Michigan State College, East Lansing, Mich.

KIPER, DONALD S.—Sales & factory representative, Butler Mfg. Co., 7400 E. 13th St., Kansas City, Mo.

LOVELL, JOHN F.—Engineer, American Machine & Foundry Co., 170 53rd St., Brooklyn 20, N. Y.

MEDDERS, DEWEY F.—County agricultural agent, Ga. Agr. Ext. Service, Extension Bldg., Athens, Ga.

MORRIS, W. H. M.—Research assistant, agr. engr. dept., Cornell University, Ithaca, N. Y.

PATEL, M. M.—Graduate student, agr. engr. dept., Ohio State University, Columbus, O.

TRANSFER OF MEMBERSHIP GRADE

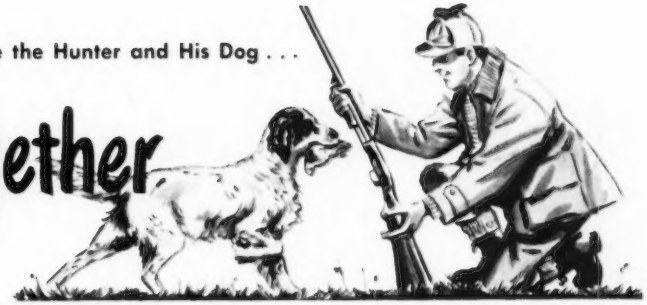
MOWERY, ALBERT S.—Associate professor of agricultural engineering, Pennsylvania State College, State College, Pa. (Affiliate to Associate Member)

OLSON, GORDON W.—Assistant field test engineer, John Deere Dubuque Tractor Works, Dubuque, Iowa (Associate Member to Member)

WOODWARD, GUY O.—Irrigation specialist, Agricultural Extension Service, University of Wyoming, Laramie, Wyo. (Affiliate to Associate Member)

Like the Hunter and His Dog . . .

they Go Together



ALL-WHEEL DRIVE

and ALL-WHEEL STEER

there's a **JOB** to be done

. . . and NO SUBSTITUTE for All-Wheel Drive and All-Wheel Steer in a motor grader . . . no way in which any rear drive, front steer machine can equal the maneuverability, power-at-the-blade, and all-around performance of an Austin-Western "88" or "99."

With All-Wheel Drive, there are no idling front wheels – no dead front end to consume power and decrease operating efficiency. All weight is on driving wheels – front and rear – contributing 100% to traction and utilizing the full power of the engine.

All-Wheel Steer provides unequalled maneuverability; saves time on every job; makes it possible to work in places where ordinary motor graders cannot go – do things they cannot do.

Get the complete story of the many additional features of these outstanding graders from your A-W distributor, or send for the latest bulletins.

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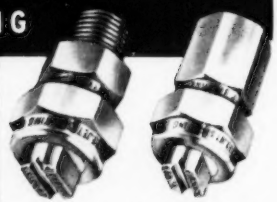
Austin Western

BALDWIN BLH LIMA-HAMILTON

SINCE 1859 – BUILDERS OF CONSTRUCTION EQUIPMENT

SPRAY NOZZLES FOR BETTER, FASTER FARM SPRAYING



TEEJET performance features

- Super precision orifice tips . . . DRILLED and MILLED for uniform spray and exact volume control.
- Interchangeable orifice tips . . . in every type and capacity from one gallon per hour and up.
- Eleven different spray angles from 0° (solid stream) to 150°.
- Unconditionally guaranteed for performance as specified.
- Factory inspection and test of all nozzles and tips before shipment.

The investment a farmer makes in chemicals, equipment and time will dependably produce a profit when TeeJet Spray Nozzles are installed on the spray boom. TeeJet nozzles are precision made to provide the best in performance from both equipment and chemicals. Proved by test in every type of farm spraying. For complete information, write for Bulletin 58 . . . the comprehensive reference manual for farm spray nozzles, strainers and fittings.

SPRAYING SYSTEMS CO.
3228 RANDOLPH ST. • BELLWOOD, ILLINOIS
Write for Bulletin 58

SPRAYING SYSTEMS TeeJet SPRAY NOZZLES

Know How and RESPONSIBILITY
are behind
"WHEELS by F&H"

Our constant search for wheel improvement takes ALL factors into account—

- The design of WHEELS and HUBS
- The design of SPINDLES and AXLES
- Selection of adequate anti-friction BEARINGS
- Selection of suitable closure SEALS
- Selection of types and sizes of rubber TIRES

INTEGRATED ENGINEERING DESIGN TEST PRODUCTION
WHEEL BUILDERS for AGRICULTURE & INDUSTRY
SINCE 1888

May we assist you in cost reduction through our PACKAGE PLAN?

FRENCH & HECHT DIVISION
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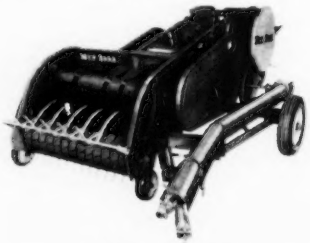
New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

A New Wire-Tie Baler

The New Idea Farm Equipment Co., Coldwater, Ohio, recently placed on the market a new model (W-51) field baler featuring straight-through design. There is no twisting or sharp turning of the hay as it passes through the machine. It has a top feed which makes for a low machine, with an inclined bale chamber and chute for easy loading onto a trailing wagon. Another feature is the feed ram which deflects or folds the hay into the compression chamber. There is no abrupt ram-



New Idea wire-tie baler

ming action, from the time the hay is picked up there is a constant movement to the bale chamber. This action saves wear and tear on the entire mechanism and reduces the shattering of valuable leaves. The baler is offered with either mounted engine or standard power take-off. All working parts are located centrally and close together. Shear bolts in flywheel and main drive sprocket guard against breakage. The wire-tying mechanism is completely self-contained and automatic. Pickup teeth retract in front of the adjustable feed auger. Six years of testing and improvement on prototypes in many different sections of the country, and under widely varying conditions, preceded the final tooling-up stage.

Cushion Seat Catalog

Milsco Mfg. Co., 2758 No. 35rd St., Milwaukee 10, Wis., manufacturers of cushion seats for original equipment manufacturers, announces a complete new catalog covering standard and new seats which have been added to the line. A feature of the catalog is the inclusion of dimensional layout sketches which are useful to engineers in planning their seating requirements. A broader choice of covering and cushioning materials is also available, including genuine flexible black leather, "Koroseal" coated duck, black artificial leather, foam rubber padding, rubberized curled hair, felt, coil springs, "No-Sag" springs, and oral valve air bags. Milsco engineers are also available for consultation on special seating problems.

NEWS SECTION (Continued from page 580)

Crop Dryer Manufacturers Organize

MEMBERS of the crop drying equipment industry at a recent meeting in Chicago have organized themselves into a new trade association. Objectives of the association include user education, market expansion, technical improvement and manufacturing problems common to the industry. Seventeen firms compose the present organization.

Officers elected are: President, J. R. Mayner, Martin Steel Products Corp., Mansfield, Ohio. Vice President, James Moore, Peirson-Moore Company, Lexington, Ky.; Treasurer, B. C. Mathews, American Crop Equipment Co., Crystal Lake, Ill.

To conduct the affairs of the association an executive committee of six was chosen. Besides Messrs. Mayner, Moore, and Mathews were Raymond Arndt, Habco Manufacturing Co., Columbus, Nebraska; Crom Campbell, Campbell Heating Co., Des Moines, Iowa; and Nolan Mitchell, Aerovent Fan & Equipment Co., Lansing, Michigan.

Aside from members of the association coming from the manufacturers, a provision has been made for membership to come also from allied organizations. Such groups may consist of institutions, associations, suppliers, publications, research agencies, or individuals having a related interest in the expansion and development of the art and science of crop drying.

Members report that although the unfavorable harvest conditions of 1951 greatly stimulated crop conditioning and crop drying, the practice is definitely established on an "every year" basis. In any year proper drying can make good crops better. The pioneers of the activity now say they are ready to show the American farmer that he can "win in '52" and every year with crop dryers.

Frank J. Zink has been elected to serve as secretary of the association.

EASY CONTROL ...ON THE SLOPES!

Terraces . . . contoured strips—both are familiar practices in controlling water and holding soil.

But, to work them requires constant maneuvering of some sort—following winding contours, making short turns, cutting back to catch point rows.

That's just where an Oliver tractor, for example, makes every operation simpler. It's so easy to handle . . . so comfortable to drive. All controls are grouped within convenient reach of toe or fingertip. Brake and clutch pedals are right in front of you. You're seated in the restful *rubber spring* seat, adjustable to your weight and leg length. For stand-up driving on the spacious platform, you merely push the seat back.

Swinging around at row ends is easy, too. Your Oliver is equipped with *double-disc* brakes . . . quick-acting, smooth, safe. The famous Direct Drive Power Take-Off eliminates shifting and re-shifting in the operation of PTO-driven machines. With the "Hydra-lectric" hydraulic system you can even change working depth with a flip of an electric switch. The OLIVER Corporation, 400 West Madison Street, Chicago 6, Illinois.

Grouped Controls

Double-Disc Brakes

Rubber Spring Seat

THE OLIVER CORPORATION

OLIVER

"FINEST IN FARM MACHINERY"

SISALKRAFT
WATERPROOF
SISAL REINFORCED
PROTECTIVE PAPERS

Farmers have proved SISALKRAFT provides dependable protection

For over 20 years many uses of SISALKRAFT Products on the farm have proved this tough, waterproof protective paper is worthy of your highest endorsement. Write for complete information on ALL farm uses of SISALKRAFT and SISALATION.

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A Handsome, Permanent Binder for AGRICULTURAL ENGINEERING

One copy **$2.80**
Two or more
$2.40 each

The ONLY binder that opens flat as a bound book! Made of durable imitation leather, nicely stamped on front cover and backbone, with name of journal and year and volume number, it will preserve your journals permanently. Each cover holds 12 issues (one volume). Do your own binding at home in a few minutes. Instructions easy to follow. Mail coupon for full information, or binder on 10-day free trial.

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SUCKERT LOOSE-LEAF COVER CO.
234 West Larned St., Detroit, Mich.

Mail postpaid *binders for Agricultural Engineering for years*
Will remit in 10 days or return binders collect.

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Address

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail, for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — APRIL — O-602-567, 603-568. MAY — O-619-570, 630-572. JUNE — O-657-575, 672-574. JULY — O-712-575, 622-576. AUGUST — O-735-577, 736-578.

POSITIONS WANTED—APRIL—W-592-109. MAY—604-113, 626-114, 601-116. JUNE—W-633-118, 656-119, 674-120, 678-121, 661-122. JULY—W-694-123, 691-124, 682-125, 700-126, 704-127. AUGUST—W-692-128, 721-129, 722-130, 695-131, 724-132.

NEW POSITIONS OPEN

INSTRUCTOR in agricultural engineering to teach farm shop, farm structures, and farm machinery to students in agriculture and agricultural engineering, in a state college in the Southwest. Vacancy to be filled by September 15 if possible. BS deg in agricultural engineering or equivalent and one or two years teaching experience, or MS deg without experience. Good opportunity for advancement. Summer term teaching required. Approximately 8 weeks vacation. Salary $4200, 12 mo. basis. O-731-579

AGRICULTURAL ENGINEER, junior or intermediate vocational instructor, to teach tractors and farm machinery in a state college in the Southwest. BS deg in agricultural engineering, or equivalent. Farm background and experience in teaching agricultural engineering in college or vocational agriculture, work in farm equipment business, or mechanized farming operation. Good personality, ability to cooperate and get along with others, initiative and imagination to develop outstanding program. Age 25-40. Salary, junior rating $3760-4580 range; intermediate $4360-5300 range. 10 mo. Additional if required to teach summer term. O-740-580

RESEARCH FELLOWSHIP in farm power and machinery in a state college in the Southeast. Project work on picking principles and establishment of specifications for the functional design of peanut picking machines. Half time for scholastic work toward MS deg. BS deg in agricultural engineering, or equivalent, with B average or better, and genuine interest in research and in the design and development of farm machinery. Early appointment desired. Appointment for 2 yr. Sponsored by a manufacturer of farm equipment. Salary $1500 plus living expenses during field operations. O-741-581

INSTRUCTOR or assistant professor of agricultural engineering for teaching farm power and research in farm machinery in a land grant university in the Northeast. MS deg preferred. BS deg acceptable if applicant has had several years of teaching or commercial experience. Interest in college work and ability to fit into the department and community. Opportunity for advancement good. Work on advanced degree, up to 6 credits per semester permitted. Salary open. O-743-582

NEW POSITIONS WANTED

DESIGN, development, research, or sales, in farm structures, rural electric or soil and water field, with manufacturer, processor, distributor, or consultant, preferably on West Coast. BS deg in agricultural engineering, 1950, Iowa State College. Farm background. Construction engineer 7 mo. Agricultural engineer with government agency, one year. War enlisted service in Navy, 2 yr. Married. Age 25. No disability. Available October 1. Salary open. W-735-133

DESIGN, development, research, sales or service in power and machinery, soil and water or work in several branches of agricultural engineering, with manufacturer, processor, distributor, or farming operation, preferably in New Mexico, Arizona, Colorado, or California. BS deg in agricultural engineering, February, 1951, New Mexico College of Agriculture. Irrigated farm background. Conservation work with Office of Indian Affairs since graduation, including supervision of design, engineering work, and earthwork construction. Single. Age 24. Slight weakness in lower legs due to polio. Available on 20 days' notice. Salary $4200. W-739-134

PROFESSIONAL DIRECTORY

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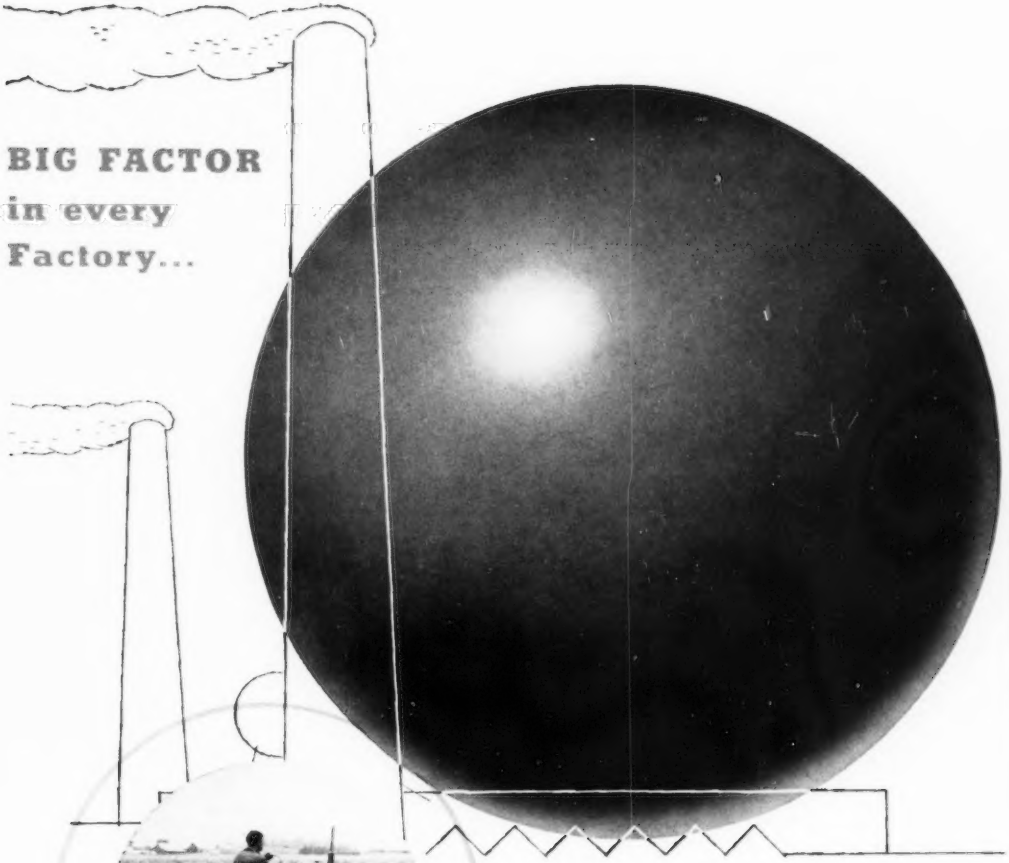
RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to ASAE members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

BIG FACTOR
in every
Factory...



...and the Products it Builds

Turret lathe or tractor, hone or harrow, shaper or spreader . . . they all depend on New Departures to reduce costs as they reduce friction. Factory machines and farm implements alike start more easily . . . carry their loads more efficiently . . . preserve their precision through a longer useful life . . . because New Departures are so accurately made, so friction-free.

The Great Ball of New Departure is your guide to *top quality* in ball bearings . . . *top service* in bearing application. Anyone who designs or builds, sells or services farm machinery or implements will do well to keep his eye on the BALL . . . to be sure of his BEARINGS.

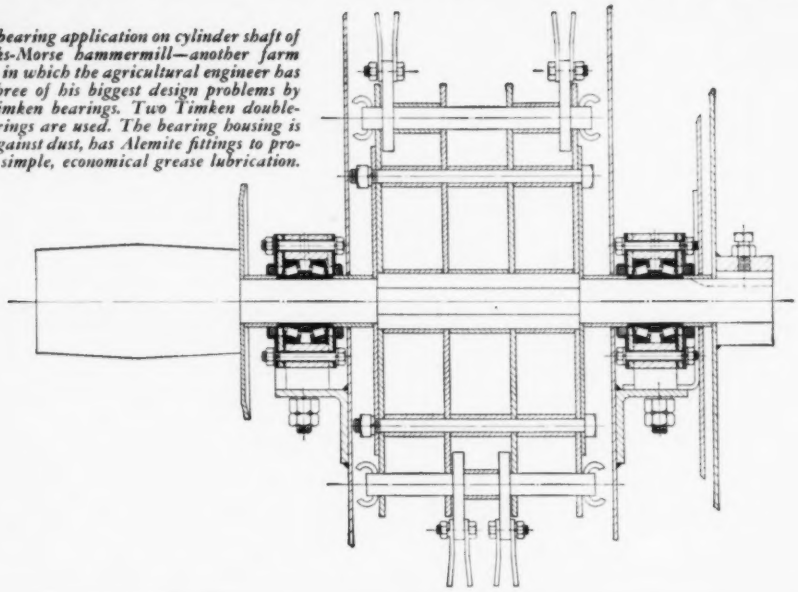
NOTHING ROLLS LIKE A BALL

NEW DEPARTURE
BALL BEARINGS

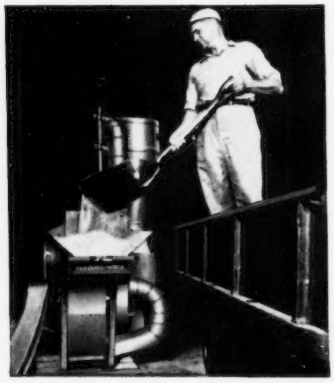
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

EVERY NEW FARM TRACTOR HAS TIMKEN BEARINGS; MORE AND MORE IMPLEMENTS ARE USING THEM, TOO!

Timken bearing application on cylinder shaft of Fairbanks-Morse hammermill—another farm machine in which the agricultural engineer has solved three of his biggest design problems by using Timken bearings. Two Timken double-row bearings are used. The bearing housing is sealed against dust, has Alemite fittings to provide for simple, economical grease lubrication.



How Fairbanks-Morse engineers solve dust and shock load problems in hammermill



TO carry heavy shock loads and to keep out dust, Fairbanks-Morse engineers specify that hammermill cylinder shafts be mounted on Timken® tapered roller bearings.

Line contact between the rollers and races of Timken bearings gives them extra load-carrying capacity. The rollers and races are case-carburized to give them a tough, shock-resistant core and a hard, wear-resistant surface. The tapered construction of Timken bearings enables them to take both radial and thrust loads in any combination.

Timken bearings make closures more effective by keeping housings and shaft concentric. Dust and dirt are kept out; lubricant is kept in. And Timken bearings make for easier hammermill operation because their true rolling motion and incredibly smooth surface finish practically eliminate friction. Moving parts rotate more freely.

More and more implement engineers are turning to Timken bearings to solve these three big design problems: 1) dirt, 2) combination loads, 3) ease of operation. And that means more and more implement users are assured of longer implement life, less chance of breakdowns in the field, higher speeds and less frequent lubrication.

For more information about Timken bearings, write now for your free copy of "Tapered Roller Bearing Practice On Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design

Tapered Roller TIMKEN BEARING EQUIPPED

NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION